DEVELOPMENTS IN
TRADITIONAL DAIRY PRODUCTS

DECEMBER 10th – 30th, 2006

CENTRE OF ADVANCED STUDIES
DAIRY TECHNOLOGY DIVISION
NATIONAL DAIRY RESEARCH INSTITUTE
(Deemed University)
KARNAL –132001 (Haryana) INDIA
2006
Published by : Dr. A. A. Patel
Head, Dairy Technology Division & Director, CAS

Cover Page Designed by : Mr. P. Narender Raju
Ms. Kirti Sharma
Dairy Technology Division

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Dr. A. K. Singh
Mr. P. Narender Raju
Ms. Kirti Sharma
COMMITTEES FOR ORGANIZATION OF THE
21ST SHORT COURSE
ON

DEVELOPMENTS IN
TRADITIONAL DAIRY PRODUCTS

(December 10 – 30, 1006)

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Dr. Abhay Kumar
Dr. S. K. Kanawjia
Dr. B. B. Verma
Dr. Dharam Pal (Course Director)

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Dr. R. R. B. Singh
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    PUNJAB
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MAHARASTRA.

14. **Mr. S. N. Raja Kumar**  
Assistant Professor (Dairy Technology)  
Kerala Agricultural University  
Thrissur,  
KERALA.

15. **Mr. Rubinder Singh Sandhu**  
Lecturer,  
Dept. of Food Technology  
Ch. Devi Lal Memorial Engineering College  
Dhabwali Road  
Sirsa,  
HARYANA
# Programme

## 10-12-2006 (Sunday)

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<th>Time</th>
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<th>Speaker(s)</th>
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<tr>
<td>10.00 AM</td>
<td>Registration</td>
<td>Dr. B. B. Verma</td>
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<tr>
<td>10.30 AM - 11.00 AM</td>
<td>Visit to Experimental Dairy</td>
<td>Mr. A. K. Sharma</td>
</tr>
<tr>
<td>11.00 AM - 11.30 AM</td>
<td>Visit to Library</td>
<td>Dr. B. R. Yadav/Mr. B. P. Singh</td>
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<tr>
<td>11.30 AM - 12.30 PM</td>
<td>Visit to Model Dairy Plant</td>
<td>Mr. B. B. Raina</td>
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<tr>
<td>1.00 PM - 2.00 PM</td>
<td>Lunch</td>
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<tr>
<td>2.15 PM - 2.45 PM</td>
<td>Introduction to the course</td>
<td>Dr. A. A. Patel</td>
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<td>2.45 PM - 3.00 PM</td>
<td>Tea Break</td>
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<tr>
<td>3.00 PM - 4.00 PM</td>
<td>Traditional Indian dairy products: Present status, scope and challenges</td>
<td>Dr. G. R. Patil</td>
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</tbody>
</table>

## 11-12-2006 (Monday)

<table>
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<tr>
<th>Time</th>
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<tr>
<td>9.50 AM - 11.30 AM</td>
<td>Visit to Cattle Yard</td>
<td>Dr. Shiv Prasad</td>
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<tr>
<td>11.30 AM - 1.00 PM</td>
<td>Inaugural session</td>
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<td>1.00 PM - 2.00 PM</td>
<td>Lunch</td>
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<tr>
<td>2.15 PM - 3.15 PM</td>
<td>Chemistry of milk in relation to manufacture of traditional dairy products</td>
<td>Dr. (Ms.) Bimlesh Mann &amp; Ms. Aparna Gupta</td>
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<tr>
<td>3.15 PM - 3.30 PM</td>
<td>Tea &amp; Discussion</td>
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<tr>
<td>3.30 PM - 4.30 PM</td>
<td>Developments in the manufacture of heat desiccated milk desserts</td>
<td>Dr. Dharam Pal &amp; Mr. P. Narender Raju</td>
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## 12-12-2006 (Tuesday)

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<tr>
<td>9.30 AM - 1.00 PM</td>
<td>Production of selected khoa based sweets (Practical).</td>
<td>Mr. F. C. Garg &amp; Mr. Ram Swarup</td>
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<td>11.00 AM - 11.15 AM</td>
<td>Tea</td>
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<td>1.00 PM - 2.00 PM</td>
<td>Lunch</td>
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<tr>
<td>2.15 PM - 3.15 PM</td>
<td>Regulatory aspects of traditional dairy products</td>
<td>Dr. Rajan Sharma</td>
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<tr>
<td>3.15 PM - 3.30 PM</td>
<td>Tea &amp; Discussion</td>
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<tr>
<td>3.30 PM - 4.30 PM</td>
<td>Technology of Paneer and Paneer Variants</td>
<td>Dr. S. Singh</td>
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<tr>
<td>Date</td>
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<td>Activity</td>
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<td>13-12-2006</td>
<td>9:45 AM - 1.00 PM</td>
<td>Commercial scale Paneer making (Practical)</td>
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<td>11:15 AM - 11:30 AM</td>
<td>Tea break</td>
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<td>1:00 PM - 2.00 PM</td>
<td>Lunch</td>
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<tr>
<td></td>
<td>2.15 PM - 3.15 PM</td>
<td>Technological innovations in the manufacture of dahi and mist dahi</td>
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<td>3.15 PM - 3.30 PM</td>
<td>Tea &amp; Discussion</td>
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<td>3.30 PM - 4.30 PM</td>
<td>Developments in the manufacture of lassi</td>
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<td>14-12-2006</td>
<td>9:45 AM - 10:45 PM</td>
<td>Cereal-based convenience formulations for traditional dairy products</td>
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<td>10:45 AM - 1:00 PM</td>
<td>Commercial scale ghee making (Practical)</td>
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<td>11:15 AM - 11:30 AM</td>
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<td>1:00 PM - 2.00 PM</td>
<td>Lunch</td>
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<td>2.15 PM - 3.15 PM</td>
<td>Technological developments in the production of shrikhand</td>
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<td>3.15 PM - 3.30 PM</td>
<td>Tea &amp; Discussion</td>
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<td>3.30 PM - 4.30 PM</td>
<td>Developments in the production of chhana and chhana based sweets</td>
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<td>15-12-2006</td>
<td>9:45 AM - 1.00 PM</td>
<td>Texture measurement of traditional dairy products (Practical)</td>
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<td>11:15 AM - 11:30 AM</td>
<td>Tea break</td>
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<td>1:00 PM - 2.00 PM</td>
<td>Lunch</td>
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<td>2.15 PM - 3.15 PM</td>
<td>Long-life traditional dairy products and desserts</td>
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<td>3.15 PM - 3.30 PM</td>
<td>Tea &amp; Discussion</td>
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<td>3.30 PM - 4.30 PM</td>
<td>Application of membrane technology for the upgradation of technologies of traditional milk products</td>
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<td>16-12-2006</td>
<td>9:30 AM - 1.00 PM</td>
<td>Commercial production of Lassi (Practical)</td>
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<td>1:00 PM - 2.00 PM</td>
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<td>2.15 PM - 3.15 PM</td>
<td>Prospects of value addition of traditional dairy products through functional ingredients</td>
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<td>3.15 PM - 3.30 PM</td>
<td>Tea &amp; Discussion</td>
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<td>3.30 PM - 4.30 PM</td>
<td>Developments in the dietetic traditional milk sweets and desserts</td>
<td>Dr. (Ms) Shashi Prabha</td>
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<td>18-12-2006 (MONDAY)</td>
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<td>9:45 AM - 1.00 PM</td>
<td>Manufacture of Rasogolla from cow and buffalo milk (Practical)</td>
<td>Dr. B. B. Verma</td>
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<td>11.15 AM - 11.30 AM</td>
<td>Tea break</td>
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<td>1.00 PM - 2.00 PM</td>
<td>Lunch</td>
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<td>2.15 PM - 3.15 PM</td>
<td>Good manufacturing practices for the traditional milk sweets</td>
<td>Mr. Ish Prasanna Paltani</td>
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<td>3.15 PM - 3.30 PM</td>
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<td>3.30 PM - 4.30 PM</td>
<td>Application of Hurdle Technology for shelf life extension of traditional dairy products</td>
<td>Dr. Surinder Kumar Gupta</td>
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<td>19-12-2006 (TUESDAY)</td>
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<tr>
<td>9.45 AM - 1.00 PM</td>
<td>Long life Paneer (Practical)</td>
<td>Dr. V. K. Gupta &amp; Mr. S. N. Raja Kumar</td>
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<td>11.15 AM - 11.30 AM</td>
<td>Tea break</td>
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<td>1.00 PM - 2.00 PM</td>
<td>Lunch</td>
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<td>2.15 PM - 3.15 PM</td>
<td>Equipments for paneer making</td>
<td>Dr. S. P. Agrawala</td>
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<td>3.15 PM - 3.30 PM</td>
<td>Tea &amp; Discussion</td>
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<td>3.30 PM - 4.30 PM</td>
<td>Texture and rheology of traditional dairy products</td>
<td>Dr. A. A. Patel</td>
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<td>20-12-2006 (WEDNESDAY)</td>
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<tr>
<td>9:45 AM - 1.00 PM</td>
<td>Diabetic Kulfi (Practical)</td>
<td>Mr. F. C. Garg &amp; Dr. Abhay Kumar</td>
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<td>11.00 AM - 11.15 AM</td>
<td>Tea break</td>
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<td>1.00 PM - 2.00 PM</td>
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<tr>
<td>2.15 PM - 3.15 PM</td>
<td>Developments in technology of basundi</td>
<td>Dr. A. J. Pandya</td>
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<td>Tea &amp; Discussion</td>
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<td>3.30 PM - 4.30 PM</td>
<td>Technologies for ready-to-reconstitute traditional milk desserts</td>
<td>Dr. R. R. B. Singh</td>
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<td>21-12-2006 (THURSDAY)</td>
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<td>9.45 AM - 1.00 PM</td>
<td>Continuous khoa making (Practical)</td>
<td>Dr. A. K. Dodeja</td>
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<td>Technologies of selected region specific traditional milk products.</td>
<td>Dr. A. K. Singh &amp; Dr. Abhay Kumar</td>
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<td>Tea &amp; Discussion</td>
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<td>3.30 PM - 4.30 PM</td>
<td>Organic milk and milk products: scope and challenges</td>
<td>Dr. D. K. Sharma &amp; Dr. D. N. Bajad</td>
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<td>22-12-2006</td>
<td>9:45 AM - 1.00 PM</td>
<td>Measurement of colour and water activity of TDP (Practical)</td>
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<td>Identification and control of safety hazards in traditional dairy products</td>
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<td>Tea &amp; Discussion</td>
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<td>Trends in packaging of traditional dairy products</td>
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<td>23-12-2006</td>
<td>9:45 AM - 1.00 PM</td>
<td>Detection of adulterants in TDP (Practical)</td>
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<td>Tea &amp; Discussion</td>
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<td>2.15 PM - 3.15 PM</td>
<td>Continuous manufacture of ghee</td>
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<td>Tea &amp; Discussion</td>
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<td>Developments in industrial methods of ghee making</td>
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<td>26-12-2006</td>
<td>9:45 AM - 1.00 PM</td>
<td>Quality assessment of TDP (Practical)</td>
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<td>Microstructure of traditional dairy products</td>
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<td>Tea and discussion</td>
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<td>Mechanization in khoa making</td>
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<td>27-12-2006</td>
<td>9:45 AM - 1.00 PM</td>
<td>Microstructure examination of TDP (Practical)</td>
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<td>Moisture sorption isotherms with reference to keeping quality of TDP</td>
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<td>Tea and discussion</td>
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<td>3.30 PM - 4.30 PM</td>
<td>Probiotic dahi: formulation and validation of health benefits</td>
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<td>28-12-2006</td>
<td>9:45 AM- 10.45 AM</td>
<td>Developments in defined strain starter culture for traditional fermented dairy products</td>
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<td>10.45 AM- 11.15 AM</td>
<td>Tea &amp; Discussion</td>
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<td>11.15 AM- 12.15 PM</td>
<td>Dairy products: An Aurvedic perspective</td>
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<td>12.15 PM – 12.30 PM</td>
<td>Discussion</td>
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<td>1.00 PM – 2.00 PM</td>
<td>Lunch</td>
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</table>
|              | 2.15 PM- 3.15 PM | Application of bacteriocins for biopreservation of traditional dairy products | Dr. R. K. Malik                                                        
<p>|              |              |                                                                     | Ms. Hitu Gupta                                                             |
|              |              |                                                                     | Mr. Prashant Chauhan                                                        |
|              |              |                                                                     | &amp; Dr. Naresh Kumar                                                         |
|              | 3.15 PM – 4.30 PM | Library consultation                                                   |                                                                            |
| 29-12-2006   | 9:45 AM- 10.45 AM | PCR-based detection of pathogens in TDP                               | Dr. (Ms) Sunita Grover                                                      |
|              | 10.45 AM-11. 15 AM | Tea &amp; Discussion                                                      |                                                                            |
|              | 11.15 AM -12.15 PM | Visit to Molecular Biology Unit                                      | Dr. V. K. Batish                                                           |
|              | 12.15 PM – 12.30 PM | Discussion                                                           |                                                                            |
|              | 1.00 PM – 2.00 PM | Lunch                                                                |                                                                            |
|              | 2.15 PM - 4.30PM | Library Consultation                                                  |                                                                            |
| 30.12.2006   | 9:45 AM- 10.45 AM | Course Evaluation                                                     | Dr. A. A. Patel / Dr. Dharam Pal                                           |
|              | 10.45 AM-11. 15 AM | Tea &amp; Discussion                                                      |                                                                            |
|              | 11.15 AM – 1.00 PM | Interaction with Faculty                                              |                                                                            |
|              | 1.00 PM – 2.00 PM | Lunch                                                                |                                                                            |
|              | 2.30 PM- 3.30 PM | Valedictory function                                                 |                                                                            |</p>
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<td>1.</td>
<td>Traditional Indian dairy products: Present status, scope and challenges.</td>
<td>Dr. G. R. Patil</td>
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<td>2.</td>
<td>Chemistry of milk in relation to manufacture of traditional milk products</td>
<td>Dr. (Ms.) Bimlesh Mann &amp; Ms. Aparna Gupta</td>
<td>12</td>
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<td>3.</td>
<td>Developments in the manufacture of heat desiccated traditional milk desserts</td>
<td>Dr. Dharam Pal &amp; Mr. P. Narender Raju</td>
<td>18</td>
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1.0 Introduction

Indian milk sweets have played a significant role in the economic, social, religious, and nutritional well being of our people since time immemorial. It is estimated that about 50 to 55 per cent of milk produced is converted by the traditional sector (halwais) into variety of Indian milk products, using processes such as heat and acid coagulation, heat desiccation, and fermentation. The market for Indian milk products is estimated to be more than Rs. 65000 crores. This fact underlines the significance of Indian milk sweets in the national economy. In view of the growing awareness towards the safety aspects of milk based sweets in India, the consumer shall prefer to buy these products from the organized sector. Despite the widespread popularity and acceptability of traditional milk products in the Indian market, the organized sector has so far not been able to tap into this market potential for many reasons such as lack of published literature on their technology, inadequacy of appropriate technologies for their commercial production, inadequacy of appropriate packaging materials and labeling to take care of new pattern in consumer demand, low keeping quality and a lack of quality assurance systems. Data from the national sample survey revealed the rising trend in the monthly per capita expenditure on milk and milk products. Interestingly, such expenditure in rural areas of the Northern India is usually higher (20-43%) than in urban areas. Recently a few organized dairy sectors have started the production of traditional milk products on a commercial scale but their impact has been limited. While many new innovations have been made recently to modernize this sector, it is necessary to look into short, medium and long term strategies to develop core technological strengths within our industry for envisioning a developed indigenous dairy products sector. A vision for this sector is only possible through identifying such core strengths and building on them.

2.0 Overview of Innovations Made So Far

2.1 Mechanization of Manufacture of Traditional Dairy Products

In order to overcome the inherent disadvantages associated with conventional methods of manufacture of traditional dairy products such as inefficient use of energy, poor hygiene and sanitation, non-uniform product quality, fatigue on the operator, etc; attempts have been made to develop batch, semi-continuous, and continuous equipments for the manufacture of these products. The first attempt to develop semi-continuous Khoa-making machine was made by Banerjee et al. (1968) which was followed by batch type semi-mechanized scraped surface heat exchanger developed by More (1989-90); batch type
mechanical conical process vat developed by Agrawala (1987) and scraped surface continuous Khoa making machines developed by NDDB (Punjanath et al., 1990), Dodeja et al. (1992) and Christie and Shah (1992). Some of these machines are already in commercial use in some dairies. The contherm-convap scraped surface heat exchanger system developed by ALFA-Laval is also being commercially used for the manufacture of Khoa.

Successful attempts have also been made to mechanize the methods of manufacture of Khoa based sweets. Palit and Dharam Pal (1998-99) developed mechanized manufacture of Burfi involving Khoa-making by continuous machine followed by kneading and heating Khoa-sugar mixture in Stephen kettle. The Sagar Dairy, Baroda manufactures kesar Peda by adopting a large-scale mechanized process which involves manufacture of Khoa using continuous machine, heating Khoa -sugar mixture in planetary mixer, cooling, mechanical forming of Peda and packaging. Similarly, Gulabjamuns are being manufactured commercially using Khoa portioning and ball forming machines followed by deep fat frying and sugar syrup soaking lines. (Banerjee, 1997).

Aneja et al. (1977) developed a prototype continuous Chhana making machine involving tubular heat exchanger, acid injection chamber, holding coil and strainer. A process has been developed on similar principle for the mechanized production of Chhana at IIT, Kharagpur, which involves indirect heating of milk in a tubular heat exchanger to 95ºC, cooling to 70 ºC, continuous coagulation with hot citric acid (70ºC) in a vertical tube, holding milk-acid mixture to permit complete coagulation, separation of whey in a continuous flow employing double wall basket centrifuge and chilling to 4º C by directly spraying chilled water on the layer of Chhana (Singh, 1994).

Considerable research has been carried out for optimization of the process for the manufacture of Paneer (Mathur et al., 1993). A prototype machine for continuous manufacture of Paneer has been developed recently at NDRI (Agrawala et al., 2001).

Developments have also been made in mechanization of Chhana-based sweets. Kumar et al. (1997) designed a screw conveyor for kneading of Chhana and a cutter provided at the exit split the Chhana into lumps of 10 g each. The lumps are made to fall on a spinning disc and stationary disc above, which converts lumps of Chhana into round balls. Another machine has recently been developed at NDRI, Karnal, which involves kneading of Chhana using screw conveyor, portioning Chhana into lump of 10 g each with a cutting device, and ball formation in a revolving cylinder (Chaudhary et al., 2001). Kumar (1998) developed a single screw vented extruder for continuous production of Sandesh.

A fully mechanized/continuous process has also been developed for industrial production of Shrikhand (Aneja and Vyas, 1983). In this process, Chakka is prepared by separating the whey from skim milk dahi employing 28” dia. basket centrifuge at 1100 rpm. The resultant Chakka, sugar and plastic cream are then mixed in a planetary mixer.

NDRI has perfected continuous equipment for manufacture of 500 kg ghee per hour (Abhichandani, 1997). This equipment is integrated with an efficient butter melter developed at NDRI.
2.2 Application of Membrane Technology in Manufacture of Traditional Dairy Products.

A process has been developed for the manufacture of Khoa using reverse osmosis (RO) (Dharam Pal and Cheryan, 1987). Khoa manufactured from RO concentrated whole milk (31% TS) was comparable in flavor and texture to conventional product, with net energy saving of 335 to 430 kcal/kg of milk.

Preparation of good quality Chhana using skim milk ultrafiltered/diafiltered retentate and plastic cream has been reported (Sharma and Reuter, 1991). Heat treated (92°C for 5 min) skim milk is subjected to ultrafiltration followed by diafiltration (23 % TS) and the resultant retentate is mixed with plastic cream and mixture heated to 90°C for 5 min and coagulated with lactic acid to develop soft coagulum. The granular mass is pressed to remove free moisture, yielding Chhana. The yield of the product is 18-19 % extra due to recovery of whey proteins.

Production of good quality Paneer using ultrafiltration has been reported by Sachdeva et al. (1993). The process offers advantages like access to mechanization, uniform quality, improved shelf life, increased yield, and nutritionally better product. The process consists of ultrafiltration of heat-treated milk, cold acidification of retentate (40%TS), packaging in containers, and texturization by microwave heating. An innovative approach employing in-package sterilization of acidified UF retentate resulting in in-package coagulation and texturization was developed by Rao, (1991). The process yields long-life Paneer-type product with three-month shelf life at room temperature.

Adoption of membrane filtration process for manufacture of Chakka and Shrikhand results in high product yield. Sharma and Reuter (1992) developed a process for production of Chakka and Shrikhand using ultra filtration technique. The process consisted of agitation of Dahi at slow speed, heating to 60-62°C for 5 min., ultrafiltration at 50°C, pressing of retentate to get Chakka and then mixing with sugar in planetary mixer. Sachdeva et al. (1994) attempted the manufacture of Chakka by reverse osmosis which involved heat treatment (90°C for 5 min.) to RO concentrate, cooling to 22°C, inoculation with 20% mixed lactic culture, incubation for 18 hrs and then removal of whey by filtration to get Chakka. Increased yield, higher solid recovery, reduced processing time, access to mechanization and alleviation of whey disposal problem were claimed as major advantages of the process.

2.3 Developments in Preservation of Traditional Dairy Products.

The short shelf life of the traditional dairy products is the major limitation in organized marketing of these products. The conventional preservation techniques such as sterilization, freezing, etc. cannot be used for traditional dairy products due to their adverse effects on sensory and textural quality. This calls for application of newer concepts of food preservation such as hurdle technology, biopreservation, modified atmospheric storage, etc.
2.3.1. Hurdle technology

The microbial stability and safety of most traditional foods is based on a combination of several preservation factors, called hurdles, which microorganisms present in food are unable to overcome. These “hurdles” include water activity, pH, heat treatment, sugar, salt, redox potential, preservatives, etc. Hurdle technology involves optimization of 3 or more hurdles so that shelf life and the microbial safety is extended without adversely affecting overall quality of the product. The advantages of hurdle technology are: (i) the sensory and nutritional characteristics of food remain close to fresh/natural ones (ii) less energy consumption (iii) autosterilization of foods is observed during storage, and (iv) less susceptible to non-enzymatic browning and lipid oxidation. The first ever-successful application of hurdle technology in India was made in author’s laboratory for preservation of ready-to-eat Paneer curry (Rao and Patil, 1999). It involved optimization of water activity, pH, extent of heat treatment and level of preservatives to obtain shelf-stable product. The product has a shelf life of one month. Recently, application of hurdle technology in preservation of Paneer (Yadav and Sanyal, 1999) and heat coagulated colostrums milk (Premaralli, et al. 1999) has also been reported. The work on preservation to Burfi and milk cake using hurdle technology is in progress at NDRI.

2.3.2 Bio-preservation

Another emerging technology for preservation of perishable foods is “biopreservation”. It refers to extended shelf life and enhanced safety of foods using their natural or controlled microflora and/or their antimicrobial products. The lactic acid bacteria synthesize variety of inhibitory substances including bacteriocins or bacteriocidal proteins. Currently large-scale attempts on application of natural antimicrobials for food preservation are being carried out. Nisin was the first recognized antimicrobial substance produced by lactic streptococci that has realized commercial application in food preservation. Use of nisin in extension of shelf life of Khoa, Lassi, and sterilized Kheer has been reported (Salahuddin, 2002).

Many other bacteriocins produced by Lactobacillus spp. such as lactocin 27, helveticin J, Lactocidin, Plantaricin A & B, Sakacin – A, breviciin, Pediocin PA-I, pediocin AcH, Pediocin-A, Leucocin demonstrate broad range of antagonistic activity against many spoilage organisms. These bacteriocins need to be exploited for preservation of traditional dairy products. They will be particularly effective when used in combination with hurdle technology.

2.3.3 Osmotic dehydration

The concentration of food products by means of product immersion in a hypertonic solution is known as osmotic dehydration. This process has received considerable attention in recent years because of potential industrial application. Compared to air drying or freeze drying, osmotic dehydration is easier as less energy consuming because of removal of water occurs without a phase change. As the food product dehydrated by osmosis is not subjected to high temperatures for extended periods, the heat damage is also minimized. The technology has great potential in near future for dehydration of indigenous dairy products.
Successful attempts have been made at author’s laboratory to dehydrate rasogolla and paneer using this technology.

2.3.4 Individual quick freezing (IQF) process

IQF process is another technology, which can be used for extending the shelf life of the traditional dairy products. IQF is a continuous process in which the product moving on the belt is exposed to a blast of extremely cold air freezing it in a matter of seconds. This serves two purposes – there is no time for the product to deteriorate and because it is frozen instantly the pieces do not stick to each other. Thus there are no clumps or blocks and one can take out even one individual piece without having to defrost or cut the frozen product. The great advantage of IQF is that the product reverts practically to its original fresh state when used for consumption. The technology will be useful for preservation of paneer, rasogulla, gulabjamun, etc.

2.3.5 Intermediate moisture products

Reducing water activity of the food product to the intermediate moisture range is a well-known method of food preservation. This technique has recently been applied successfully at NDRI to preserve paneer cubes (Surinder Kumar, 2003). The intermediate moisture paneer has a shelf life of 4 months at room temperature and can be reconstituted within five minutes.

2.4 Developments in Packaging

The traditional dairy products have been conventionally packaged in dhak leaves, paper cartons, polyethylene bags or cardboard boxes. These traditional packages do not provide sufficient protection to the product from atmospheric contamination and also do not have the functional properties in order to preserve the initial quality of the product for a longer time. As a result, the products soon lose their typical body and texture, pick up foreign odors, become rancid/oxidized and give undesirable appearance. These packages are also not suitable for far-off transportation and outstation retail sales (Goyal, 1997-98).

Recently, with the rapid developments in packaging technology, substantial progress has been made in packaging of traditional dairy products. Packaging of Khoa in laminates of paper/Al.Foil/LDPE (55-60 gsm, 0.02 mm and 159 gauge), and Polycel (300, 150 gauge poly, colored) have been found to be quite satisfactory for Khoa. In these packages, Khoa can remain in good condition for 10 days at ambient temperatures and 60 days under refrigeration conditions. However, by using 4-ply laminated pouches made of PP/LDPE/ Foil/LDPE, the shelf life of Khoa can be increased to 14 days at 30°C and 75 days in cold storage (Kumar et al. 1975). For packaging of Chhana, polycel (300 and 150 gauge, colored ) is good, low-cost packaging material.

Ghee is generally packaged in lacquered or unlacquered tin cans of various capacities ranging from 250g to 5 kg for retail sale and 15 lit for bulk sale. Some dairies pack ghee in polyethylene bags. Other recommended packages for packaging of ghee are polyester coated cellophane, polyester, nylon-6, food grade PVC or their laminates.
Recently, systems have been developed for assembly line packaging for Shrikhand, Dahi, Misti Doi, Paneer, etc. and are being used in organized sector. Polystyrene or polypropylene cups used for packaging of Paneer extend shelf life of 180 days at -18°C and 30 days at 5°C. Rasogolla are being packed in lacquered tins with a shelf life of 6 months at room temperature (Chandan et al., 2002). Polypropylene trays covered with transparent, coloured MXXT are recommended packages of Burfi, Peda and Kalakand (Goyal 1997-98). Low weight, leak-proof lacquered kulhers for packaging dahi, misti doi, etc. have been developed at NDRI, which give better shelf life than plastic cups.

2.5 Convenience Traditional Dairy Products

The changing life-styles and increased purchasing power especially among urban population has necessitated the research efforts for formulating ready-to use traditional milk products with added convenience, enhanced shelf life, added nutritive value, and with attractive packaging. Recently, number of such convenience products viz. Khoa, powder, Kulfi mix, Gulabjamun mix, Rasogolla mix, Burfi mix, Chhana powder, instant rice Kheer mix, Makhana kheer mix, Shrikhand powder, Lassi powder, dried carrot milk food mix, ready-to-eat Paneer curry, Chakka powder, Kadhi mix, Palada mix, Rasmali mix, basundh mix, etc. have been developed at NDRI and elsewhere, some of which are already being manufactured commercially.

3.0 Scope for Modernization

Deep rooted tradition offer a considerable scope for organizing and channeling the amount of milk going for conversion into Indian milk sweets. The major strength of the Indian milk sweets sector is the mass appeal enjoyed by such a wide variety of products. The market for these products far exceeds that for western dairy products. Their operating margins are also much higher, mainly due to lower raw material cost. It is estimated that the raw material costs of Shrikhand, Rasogolla, Gulabjamun, Khoa sweets (Peda, Burfi, Kalakand), Sandesh and Paneer is 29, 33, 34, 35, and 65 per cent of the sale price, respectively. For western dairy products, comparative costs are relatively much higher varying from 7 - 80%. (Chandan et al., 2002). Their production and marketing can bring about a remarkable value addition to the extent of 200 per cent, as compared to only 50 percent obtained by western dairy products. They can do wonders for organized dairy sector to better its prospects of financial stability and steady growth.

Increasing demand for these products present a great opportunity for the organized dairies in the country to modernize and scale-up the production. A GCMMF-TCS Survey report has given projected demand of Ghee, Paneer, Shrikhand, Rasogolla, and Gulabjamun to be 200, 16, 5.7, 6 and 5.9 thousand metric tones by year 2009 (Misra, 2000). Therefore, the expanding business prospects provided by these products and their accompanying value-addition call for a thorough study of this sector. There is a need to look into various issues and accordingly re-evaluate and re-engineer ourselves to modernize traditional dairy products sector.
4.0 Issues, Strategies and Vision

4.1 Production of Indigenous Milk Products by Organized Sector

Large-scale manufacture of these products in a hygienically safe manner with assured quality control and proper packaging will certainly do wonders for this sector not only in India but also abroad. Lead has initially been taken in this regard by NDDB’s Sugam dairy and since has been followed by Saber and Rajkot dairies in Gujarat; Warna dairy, Maharashtra; dairies in Madras, Bangalore, Hyderabad and Chittoor in South India, Mother dairy, Calcutta; KCMF, Trivendrum, COMFED, Patna; and many others. This organised production of indigenous dairy products, however, is miniscule as compared to total volume traded in the market. By 2020, we should shift at least 25% of production of Indigenous dairy products to the organized sector.

In spite of several innovative efforts made in the mechanization of manufacture of indigenous dairy products, adoption of these innovations by the industry is very limited. There may be several reasons for this. One reason may be our typical mindset. We appear to have lost faith in our abilities and ourselves. We seem to have a blind admiration of anything done outside our country and blindly believe whatever is foreign. We are by and large reluctant to adopt technologies developed locally.

It would also be pertinent at this stage to ask whether we need continuous systems or batch system when only a fraction of total ethnic products are processed in organized sector. Will it not be more appropriate to develop and promote batch type units so that mechanization of production in the small size units in the unorganized sector is effected thereby improving the hygienic quality of the products marketed by this sector?

The organized production does not necessarily mean large-scale production. We cannot afford to forget a large number of small and tiny manufacturing units, which are in the unorganized sector. A number of them have people with great innovative capabilities and basic skills. These talents need to be properly organized for hygienic production and marketing.

There is also a need to facilitate formation of consortia of dairy industry to fund research to (i) develop mechanized and energy efficient systems for manufacture and packaging of indigenous dairy products and (ii) develop value added indigenous dairy products for the future.

4.2 Packaging of Traditional Dairy Products

Poor packaging of traditional dairy products is another big area, which should be strengthened. Most of these products particularly sweets are sold in open condition which is a great source of contamination. Even products prepared by organized/large dairies, for example khoa and paneer are not properly packaged. No packaging system/machine is available for traditional milk sweets and the units available for non-dairy sweets are unsuitable for milk sweets. The methods of manufacture of many sweets also do not
commensurate with the continuous packaging system. The appropriate and environmental friendly packaging materials are to be identified. Complete packaging systems that are in harmony with the production line will have to be adopted.

4.3 Training of Small-Scale Operators

Most of the trade of Indian milk sweets is with the *halwais* and the small-scale operators. Most of them have art and skill of manufacturing varieties of indigenous dairy products. However, no attention is paid by them on quality of milk, hygienic handling, proper packaging and storage due to ignorance. The training of operators in this sector in hygienic handling and quality control aspects will go a long way in improving the quality of these products. The regional Agricultural Universities and Krishi Vigyan Kendras will have to play active role in training of small entreprenuers.

4.4 Understanding Basic Characteristics of Indigenous Dairy Products

In order to modernize the Indian milk sweets sector, it is necessary to understand the basic characteristics of these products. The knowledge of these characteristics would contribute a great deal in design of equipments and standardizing scaled-up methods for manufacture of these products.

A variety of traditional dairy products are produced in India, most of which are region specific. Most of these products have been characterized for their chemical composition, sensory attributes and rheological and microbiological characteristics. Wide variation in composition of these products is observed due to variation to the method of manufacture, concentration ratio used, sugar level, type of milk (i.e cow, buffalo or mixed). There is a need to determine the consumers’ preference about the most desirable attribute of these products in different regions of the country so that the organized dairies may adopt the same.

Similarly, characterization of various food products on the basis of their rheology and microstructure forms the backbone of the scientific approach to product/ process development and of quality assurance in modern industrial practices. The current trends round the globe favour such studies to facilitate product description/specification for promoting process control and for international trade. At a juncture when the need for modernizing the manufacturing and marketing of traditional milk products is being emphasized in India, such rheological and electron microscopic studies would be *sine qua non* to obtain much needed information for product/process/equipment development. In the past few years, some work has been directed to study the rheology and microstructure of selected indigenous dairy products such as *Paneer, Khoa, Rasogolla* and *Sandesh*. It is also necessary to understand the kinetics of texture formation during manufacture of these products and the molecular level changes in the constituents of milk during processing. Any equipment designed without taking into consideration these basic aspects is less likely to be accepted by the industry as the product obtained using such equipment would lack the desirable texture.
4.5 Establishing National Standards for Indigenous Dairy Products

Lack of quality/legal standards and quality assurance systems is one of the bottlenecks in improving the quality of these products. While legal standards for some of the milk sweets have been laid down, there is an urgent need to formulate the national standards for all the Indian sweets marketed in the country. There is also need to evolve the quality assurance system to meet the international standards of food hygiene and food safety.

4.6 Innovation in Value Added Indigenous Dairy Products

The markets of conventional indigenous products are increasingly getting overcrowded and our future success will depend on our ability to provide innovative products, which consumers want and need. Whatever the innovation - products, processing method or packaging - it should meet the real consumer need. We know today’s families want “grab-and-go” convenience. They are also concerned about nutrition and health. Different ages and demographics want different things. Therefore, investment at this level is essential if we are to respond rapidly to customers who are increasingly demanding new and different taste experiences from products that are also competitively priced. New variants of sweets can be developed. Indigenous dairy products containing health-promoting ingredients may be developed and promoted. Host of ingredients such as dietary fibre, cholesterol reducing phytosterols & phytostanols, minerals and vitamins, berries and cherries with its anthocyanins that prevent cancer etc. are available for value addition of traditional dairy products. Development of dietetic sweets is another area needing attention.

4.7 Innovation in Marketing

Innovation in marketing is equally important. It is possible to popularize indigenous dairy delicacies through the fast food chains or franchising of some popular brands of Indian dairy delicacies may be promoted. Collecting market intelligence to inspire confidence among prospective entrepreneurs to take commercial production of traditional dairy products in India and abroad is also essential.

5.0 Epilogue

The Indian milk sweets enjoy mass appeal, give high profit margins and have high export potential. There is an urgent need to modernize this sector to produce high quality products with long shelf life. We need to generate basic data on these products which will help for designing of new equipments or for intelligent selection of existing food processing and packaging lines. Great scope also exists for improving the shelf life of milk sweets by employing newer preservation techniques. While lots of innovations have taken place recently, these innovations have not percolated to the actual users. Industry-R & D organization links need to be strengthened. Collaborative efforts of industry, unorganized sector, equipment manufacture and R & D institutions are required for all round development of this sector.
6.0 Suggested Readings


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1.0 Introduction

Milk is an extremely complex biological fluid with scores of nutrient chemicals contained in a fluid with characteristics of three physical phases: a dilute emulsion, colloidal dispersion and a solution. The emulsion can be broken by low speed centrifugation and the milk separates into lipid and aqueous phases or compartments, each with a characteristic composition. With ultracentrifugation the casein micelles precipitate, bringing some other proteins such as lactoferrin with them. The supernatant remaining after this process has the characteristics of a true solution. The chemical makeup of milk and its physicochemical behavior provide scientific basis for process of milk and manufacture of products. In India, milk from buffalo and cow (desi, cross breed and exotic) is commercially important. Depending on its characteristics, each type of milk is eminently suitable for certain types of region specific indigenous traditional milk products. These Indian traditional dairy products can be classified into the following broad categories:

2.0 Heat Desiccated Milk Products

Heat desiccated milk products such as khoa – an intermediate concentrate that is the base for a wider range of mithais including gulabjamun, burfi, peda, kalakand, rabri, kulfi and their variants. The heat processing and accompanying reduction in water activity result in substantial destruction of pathogenic and spoilage micro organisms as well as inactivation of enzymes. Besides, desirable heat induced chemical interactions among milk constituents result in reduction of redox potential and water activity which extend the product shelf life. Beside these desirable flavours, textures and overall acceptability of these products is enhanced by heat processing. The main reaction in the preparation of khoa is the heat denaturation and coagulation of milk proteins. Most of the albumins and globulins are rapidly denatured, the protective properties of the other colloids are destroyed early in the boiling process, and the process is accelerated by the incorporation of air and the frothing during stirring. Total heat coagulation of the proteins occurs when the boiling mixture thickens to a buttery consistency in the pan. Coagulation of milk proteins is brought about by heating to 132 – 136 °C. Albumin and globulins are coagulated below 100°C, while casein is coagulated above 100 °C. During desiccation whey proteins are almost fully denatured from colloidal state of non-dispersible state. The factors that influence the heat coagulation are temperature and time of holding, concentration of casein, acidity of milk, salt balance and precise heat treatment. The color of milk changes from light to a more intense shade of the color due to denaturation and coagulation of protein. Due to vigorous agitation of milk at high temperature the fat globules are appreciably sub-divided. Almost half of the globular fat is released as free fat-the extent of which depend upon the type and fat content of milk and manufacturing process usually 44.8 to 62.8 % of fat appears as free fat in khoa. Patel, et. al,
(1990) have found a positive and significant correlation in total solids and hardness. The fat level is usually adjusted to 4% for cow milk and 5% for buffalo milk. The yield of khoa depends upon the type of milk used when milk is standardized to 4.5% fat and 8.5% SNF; its yield is about 20% for buffalo milk. Khoa from buffalo milk is considered distinctly superior, being whiter in color and having smooth body and granular texture. These characteristics are considered desirable for making high quality sweets.

The quality of khoa is better when made from buffalo milk as khoa from cow milk is inferior due to its moist surface, sticky and sandy texture which is not considered suitable for the preparation of sweetmeats (De and Ray, 1953). The higher emulsifying capacity of buffalo milk fat due to the presence of larger proportion of butyric acid containing triglycerides (50%) compared to only 37% in cow milk fat may be responsible for smooth and mellowy texture of its khoa (Sireller, 1996). Good quality khoa can be prepared from cow milk with the incorporation of whey protein concentrates (5%) and keeping the total solids of the product low, as higher total solids in WPC containing khoa adversely effect the rheological parameters (Patel, et. al, 1993). Rajoria, et. al, (1990) studied the effect of milk quality on the chemical, sensory, rheological properties of khoa. They observed that khoa from slightly soured milk (0.2% lactic acid) did not have much adverse effect on the flavour of khoa while khoa prepared from excessively sour milk had acidic smell, which has improved but not totally suppressed by neutralization of excessively soured milk had a salt taste. The coarse structure of the khoa is increased with increase in the acidity of milk. Increase in size and hardness of the grain lead to poor body and texture of khoa. Smoothness of khoa was also adversely affected by the developed acidity. The hardness of khoa was observed to increase from 19.47 mN to 22.85 mN and 28.44 mN due to increase in acidity to 0.19% and 0.27% lactic acid respectively. Gumminess and chewiness of khoa was also increased due to developed acidity in milk and was reduced by neutralization of the same. Khoa from excessively high acidic milk is sour in taste.

3.0 Heat and Acid Coagulated Products

Paneer and Chhana are the two important heat and acid coagulated products. Paneer, the indigenous variety of cheese is obtained by acid coagulation of the heated milk. The phenomena of coagulation involve the physical and chemical changes in casein brought about by the combined heat and acid treatment. This treatment leads to formation of large structural aggregates of casein from normal colloidal dispersion of discrete casein micelle in which milk fat and coagulated serum proteins are entrapped together with whey. During formation of coagulum, major changes include the progressive removal of tricalcium phosphate from the surface of casein and its conversion into monocalcium phosphate. Further calcium is progressively removed from calcium hydrogen caseinate to form soluble calcium salt and free casein. When the pH of the milk system drops, the colloidal particles become isoelectric i.e. the net charge becomes zero with the formation of zwitter ion. Under such circumstances the dispersion is no longer stable; the casein gets precipitated and forms a coagulum. Good quality paneer is characterized by a white color, sweetish, mildly acidic, nutty flavor, spongy body and close knit texture. Buffalo milk paneer is of good quality as it has all these attributes. On the other hand cow milk paneer is of inferior quality as it is too soft, fragile and its pieces loose their identity on cooking (Sachdeva, et. al, 1985). The lesser proportion of solid fat due to lower proportion of casein in the micelle state, smaller size of
casein micelles and fat globules and lower content of calcium in it, particularly in colloidal state, may be responsible for inferior quality of paneer from cow milk. The cow and buffalo milk mixed in the ration of 50:50 having a fat percent of 5 yields a superior product than cow milk alone. Acidic milk having a titratable acidity of 0.2-0.3 % lactic acid yields a product with inferior quality. The COB positive milk with normal acidity is also not suitable for paneer making due to weak body and texture, more moisture and acidic milk (Vishweshwaraih and AnantKrishnan, 1985).

Chhana, a base product for a large variety of Indian delicacies namely rasogolla, chhana gaja, sandesh, cham cham, rasmalai, pantoha, raj bhog, chhana murki etc is also a heat acid coagulated product. It differs from paneer as no pressure is applied to drain the whey and its pH is slightly higher. Scanning electron microscopy of defatted sample of chhana revealed a conglomerated compact protein matrix with numerous small uniformly distributed pores. The coalesced, smooth protein bodies are joined with thick bridge in which fat globules embodied in coalesced casein micelles with some whey filled space at edge. The agglomerated large casein particles formed continuous thick strands joined together with numerous spaces in between (Adhikari, et. al, 1992). Cow milk is better suited for chhana making because it produces chhana with soft body and smooth texture which is better for sweets. Higher concentration of casein more in the micelle state with bigger size of the cells, harder milk fat due to larger proportion if high melting triglycerides in it with bigger size of globules and higher content of calcium more in the colloidal state in buffalo milk (Sindhu and Singhal, 1988) may be responsible for harder and less cohesive chhana.

De and Ray (1954) and Tagtiani, et. al, (1960) observed that cow milk chhana was soft bodied with small grainy smooth texture and more cohesive compared to hard bodied granular hard textured chhana from buffalo milk. Boghra (1988) found that chemical quality of chhana retained less moisture and lactose but higher total solids as compared to cow milk chhana. Retention of minerals (Ca, Mg, P, Citrate, Fe and Zn) was also higher in buffalo milk chhana. On the other hand, it had less Na, K and Cl compared to cow milk chhana. The hardness of chhana is directly related to calcium content of milk. Addition of calcium and magnesium chloride produces hard chhana while sodium chloride, sodium acetate and sodium citrate did not affect the body and texture of chhana. Chhana prepared from cow milk (4-5 % fat) is most suitable for rassogolla. Lower fat content below 3 % produces chhana unsuitable for rassogolla. Adulteration of milk with starch produced a gelatinous mass while the presence of colostrums in milk led to pasty texture. Both of these products were unsuitable for sweet making (Ray and De, 1953). Fresh milk is preferred for chhana production. Acidic milk produces undesirable sour smell and bitter taste in chhana. When acidity is neutralized with sodium carbonate the chhana prepared can be used for sandesh only.

Although buffalo milk is not preferred for production of quality chhana required for making sweets, it can be used in the following ways:

i. A mixture of buffalo milk and cow milk in the ratio of 1:3 yields chhana with soft body and smooth feature making it suitable for preparing both rassogolla and sandesh.
ii. Adding to the buffalo milk with a mixture of sodium diphosphate and disodium phosphate or sodium citrate at 0.01-0.02 % and storing the hot milk for some time before precipitation produces a soft chhana. Addition of sodium citrate converts some of the insoluble calcium into soluble salts in the buffalo milk and this helps in the production of softer chhana similar to that produced from cow milk.

Sanyal, *et. al*, (2006) indicated that addition of carrageenan to buffalo milk before coagulation considerably improved the quality of sandesh as compared to control.

### 3.0 Cultured/Fermented Products

Chakka, Shrikhand, Dahi, Misti dahi and lassi are the fermented indigenous manufactured and consumed in India. Chakka is the semi-solid curd mass obtained by the removal of whey from dahi (curd) is commonly known as chakka which is the base material for making Shrikhand. Chaka has a milky white color, smooth texture and mild acidic flavour. Increase in the temperature of heating the milk before coagulation led to an increase in yield due to complete denaturation of whey protein and precipitation with casein (*Aneja, et. al*, 1977).

Shrikhand with its distinct taste richness delicacy, diversity and fairly log shelf life is very popular in India, particularly in states like Gujarat and Maharashtra. Beside fresh milk, other products like diluted condensed milk, reconstituted milk, buttermilk, skim milk and condensed milk have been used for preparation of Shrikhand. However quality of Shrikhand obtained from these products is inferior (*Patel and Chakraborty*, 1985b). Buffalo milk prepared for making Shrikhand due to higher yield and better quality of the finished product obtained from it (*Kadan et al*, 1984). *Boghra* 1988 found that buffalo milk Shrikhand is rich in minerals including calcium, magnesium, phosphorous, copper, iron and zinc compared to cow milk Shrikhand. However sodium, potassium and chloride were less in buffalo milk Shrikhand. Similarly, higher proportions of dissolved proportions of calcium, magnesium, phosphorous were found in buffalo milk Shrikhand than cow milk Shrikhand.

Dahi is an indigenous dairy product obtained by lactic acid fermentation of milk. A good quality dahi is of firm and smooth consistency with sweet aroma and pleasant taste. The composition of dahi is similar to the milk from which it is produced. Dahi from buffalo milk is superior in body and texture than cow milk dahi. Higher total solids, fat and proteins in buffalo milk, higher proportions of casein, more so in the micellar state in the form of larger micellar, higher solid fat due to larger proportion of high melting triglycerides in the form of larger fat globules and higher content of calcium more so in colloidal state milk (*Sindhu and Singhal*, 1988) may be responsible for better dahi from buffalo milk. During fermentation of milk, lactic acid bacteria is the culture hydrolyse the lactose into lactic acid as a major product, which contribute to more than 90 % to the acidity of dahi. Diacetyl is the major flavour compound. A portion of lactic acid combines with calcium to form calcium lactate. The casein devoid of calcium is coagulated on reaching its isoelectric point. The fermentation is accompanied by gelling of solids, principally the protein and syneresis manipulated by appearance of thin exudates of clear whey on the surface of the product. Decrease in charge on the fat globules brings them together and the raises to the surface.
In the eastern region of India sweet variety of dahi known as Misti dahi is popular. It is produced with the addition of 6-6.5% sugar to milk either during boiling or at setting stage. Prolong heating of sweetened milk at low temperature leads to milk solid concentration and development of brown color. A characteristic cooked and caramelized flavour and firm body develops after setting the curd. The ultrastructure of misti dahi shows a clear protein matrix with uniform distribution of lactic acid bacteria, thus forming clusters and chains entrapping whey in between. The extent and interlinkages of casein appeared to determine the phenomenon of wheying off which subsequently affect the lactic acid bacteria in matrix. The lactic acid bacteria are spotted in pockets distributed in the protein matrix of coagulum (Gupta, et al, 2000).

4.0  Fat Rich Products

In the traditional Indian dietary regimes, milk fat in the form of malai (cream), makkan (freshly churned butter) and ghee contributes significantly towards nourishment of people of almost all age groups. Buffalo milk is better suited for the manufacture of fat rich dairy products as compared to cow milk due to its higher fat, bigger size of the globule and higher proportion of solid fat leading to the higher yield, lesser loss of fat in butter milk or skim milk, easier preparation of cream or butter and better texture (Sindhu, 1996). The fatty acid composition of buffalo ghee is different from cow ghee. On the other hand short chain concentration of poly unsaturated fatty acid (PUFA) is higher in buffalo ghee compared in cow ghee leading to lower oxidative stability. Moreover buffalo ghee is poor in dienoic and trienoic fatty acids. Based on the crystallization behavior, the separation of triglyceride into higher melting triglyceride (HMT), medium melting triglyceride (MMT) and low melting triglyceride (LMT) revealed that buffalo ghee contains a higher proportion of 9-12% of MMT than 5-6% of cow ghee leading to the bigger grain formulation and better texture of ghee. Buffalo ghee has higher melting point, density, specific gravity and saponification value but lower BR reading, refractive index, R.M. value and Polenske value than cow ghee is also higher than buffalo ghee.

The buffalo ghee is whitish with greenish tinge due to the presence of tetrapyragole pigments-biliverdin and bilirubin which is released from the protein during the preparation of ghee. On the other hand cow ghee is golden yellow in color due to the presence of carotenoids in it. Keeping quality of ghee from cotton seed fed animal is better due to the presence of gossypol – a phenolic substance present in cotton seed which act as antioxidant.

5.0  Suggested Readings


1.0 Introduction

The traditional milk sweets and desserts prepared by heat desiccation of milk and by subsequently adding sugar which are being made since time immemorial, have great relevance to Indian culture. The important products that come under this category are khoa-based sweets, viz. burfi, peda, kalakand, milk cake; and rabri and basundi. Each of these sweets has its unique flavour and texture. Most of these sweets are essentially made by *halwais* by their own experience and skill hence are encountered with some inherent problems such as large variations in chemical, sensory and rheological qualities, small scale batch operations, poor packaging and low shelf life. The small-scale manufacturers are unaware about emerging trends in processing, quality control, packaging and fuel economy in manufacturing these dairy products.

Traditional milk sweets have a distinct advantage in that they are value added products and have great mass demand. The Indian dairy industry has not yet included these popular sweets in their products list because the complete mechanized/continuous processes for manufacture and packaging systems of these products are not available. It is not possible to provide as artistic and personal touch to each type of product by mechanized systems as in the case of conventional methods. Keeping in view the changed scenario of Indian dairy industry in respect of increased availability of milk, globalization and entry of private sector in the trade and more demand for value added products, the heat desiccated traditional milk sweets have great scope for export to overseas markets with lots of Indian diaspora. In this article the technological advances that have taken place in heat desiccated sweets such as burfi, peda, gulabjamun, milk cake and rabri are discussed. Basundi, which is also a popular heat desiccated milk dessert, will be discussed in a separate write-up.

2.0 Burfi

Burfi is a popular milk based confection which is essentially made from khoa. Sugar is added in different proportions to have khoa and other ingredients incorporated according to the demand of consumers. Several varieties of burfi are sold in the market depending on the additives present, viz., plain mawa, pista, nut, chocolate, coconut and rava burfi. A lot of variation can be observed in physical attributes of market samples. Good quality burfi, however, is characterized by moderately sweet taste, soft and slightly greasy body and smooth texture with very fine grains. Colour, unless it is chocolate burfi, should be white or slightly yellowish. The chemical composition of burfi depends on the quality and
composition of raw materials, amount of sugar and other ingredients and extent of heating. Various workers have reported wide variations in the composition of market samples.

2.1 Traditional Method of Manufacture

The method of manufacture of burfi has been standardized for small as well as for large scale. The processing steps involved in the manufacture of burfi by the traditional method have been optimized by many workers (Sachdeva and Rajorhia, 1982; Ramana, et al, 1983; Reddy, 1985 and Bhatlele, 1983). The standardized method that produced most acceptable product involved standardization of buffalo milk to 6% fat and 9% SNF, preparation of Pindi khoa with about 30% moisture, addition of sugar @ 30% of khoa (or 6% of milk) at 60 °C, kneading the mixture at 50 °C, addition of additives, setting in trays and cutting in shapes of desired size and shape (Reddy, 1985).

2.2 Mechanized Method of Manufacture

With a view to overcome the limitations of small scale batch method of burfi making, a mechanized method of manufacture of burfi was developed by Palit and Pal (2005) adopting existing units such as scraped surface heat exchanger (SSHE) and Stephen processing kettle. It involved continuous manufacture of khoa using two stages thin film SSHE developed by Dodeja, et al. (1992), addition of sugar @ 30% as recommended by Reddy (1985); proper blending and kneading of khoa with sugar in Stephen processing kettle. Directly from the Stephen kettle, burfi was hot filled (at about 60 °C) into previously cleaned and sterilized polystyrene containers of 250 g capacity and covered with plastic lids.

2.3 Shelf life Extension of Burfi

Burfi prepared by traditional method and sold in paper board boxes remains organoleptically acceptable for about one week at room temperature. Surface mold growth and surface drying are the most common defects under ambient conditions of storage. The shelf life of burfi in parchment paper at 30°C is about 10 days. Packaging of burfi in presterilized (0.5% H₂O₂) cryovac pouches increased the shelf life upto 30 days (Palit, 1998). Palit and Pal (2005) reported that filling of burfi containing 0.1% potassium sorbate into polystyrene containers followed by vacuum packaging increased the shelf life to more than 60 days.

Corn syrup reduces the water activity, thereby exerts an inhibitory influence on the growth of the bacteria. With a view to extend the shelf life and improve the texture of burfi, Reddy (1985) studied the effect of replacing 50% of cane sugar with corn syrup (42 DE) and observed that desired results were obtained. It may also observed that an equilibrium relative humidity (ERH) of 70% for burfi samples having moisture content of about 15% was found to be optimum for storage at 30°C. Higher ERH encouraged the mould growth and the lower impaired the texture of burfi making the product unfit for consumption.

Sodium metabisulfite (Na₂S₂O₅) and potassium metabisulfite (K₂S₂O₅) are well known antimicrobial agents commonly used in food industry. Sarkar, et al, (2003) studied the possibilities of extending the shelf life of burfi using sodium metabisulfite and potassium metabisulfite and reported that buffalo milk burfi can be stored for 50 days at 7 ± 1 °C using
these preservatives without showing any perceptible organoleptic, textural and chemical changes or mold growth.

3.0 Peda

As compared with burfi, peda is granular in texture having dry body because of comparatively lower moisture content. There are numerous varieties of peda, their methods of manufacture vary from region to region depending on the consumers requirements. Consequently, the sensory and chemical attributes of peda vary to a great extent. In a study conducted by Patel, et. al, (2006) it was reported that the peda manufactured using traditional methods was superior in chemical and sensory quality than those manufactured using mechanized methods.

3.1 Traditional Method of Preparation

Basically the method of preparation of peda is identical to that of burfi preparation wherein a mixture of khoa and sugar is heated at low-fire till desired texture is attained. However, depending on the type of pedas such as plain, kesar and brown peda etc. it slightly differs from burfi. Plain peda is made into round balls of about 20 – 25 g size, normally by rolling between the palms. The product may also be formed into different shapes and sizes using different dies/moulds. Peda is usually packed in paper board / boxes having a parchment paper liner or grease proof paper liner (Reddy, 1985). In another study, Patel (1986) reported that peda can be prepared with 5 liters milk taken in a pan as a batch and by adding 450 g of sugar to boiling milk and subsequently following the traditional method. It was reported that by this method 168 kg of peda can be prepared from 600 litres of buffalo milk in a shift of 8 hr on a set of six crude oil combustion furnaces. This method is adopted in the rural milk centers in Kutch district of Gujarat.

Brown peda is a type of peda that is characterized by caramelized color and highly cooked flavor. Depending on the area of consumption, it differs in the intensity of characteristic color and flavor. It is popular in Uttar Pradesh as Mathura peda, in Karnataka as Dharwad peda and in Maharashtra as Mishra peda. In almost all of these types, khoa is first cooked to brown colour in ghee and then peda is prepared from it by blending sugar and other additives. The analysis of the market samples from different parts of the country revealed significant variation in the quality of brown peda (Londhe, 2006). Among the various samples analyzed, Mathura peda was reported to be superior in quality than other types. Londhe (2006) had standardized the method of manufacture of brown (Mathura) peda. It involved selection of buffalo milk (5.9% milk fat) and boora i.e., sifted sugar (30% on khoa basis) and addition of boora after khoa was prepared.

3.2 Industrial Method

The industrial method of converting khoa into kesar peda had been developed at National Dairy Development Board (NDDB), Anand. It has been subsequently adopted later by Sugam Dairy, Baroda. It involved heating khoa to 60 °C and adding sugar, flavor and other ingredients in a planetary mixer. The peda mass thus obtained was cooled to 5 °C by
transferring into a cold room and fed to peda shaping machine followed by packing and storing under refrigerated conditions (Banerjee, 1997).

### 3.3 Developments in the Process Modification of Peda Making

Many workers have studied different methods to modify the process of peda making. Reddy (1985) developed a process for the preparation of plain peda using skim milk powder (SMP) and cream. It involved uniform mixing of SMP (50 parts) and 30% cream (100 parts) with the help of mechanical blender. Slurry obtained was taken into the stainless steel kettle where steam pressure of 0.75 kg/cm² was maintained. The contents were heated with constant stirring and scraping till pat formation stage. Subsequently sugar was added at about 80 °C. The mixture was cooled to 35 °C before moulding and packaging. Mane (1994) also studied the use of skim milk powder for preparation of peda. The study involved homogenous dissolution of skim milk powder in the minimum possible quantity of water at about 50 °C followed by addition of ghee in dissolved skim milk powder. Subsequently, heating with continuous and vigorous stirring in open pan till the formation of pat so as to have proper incorporation of fat in the body of dough. The dough was heated on a very low flame and sugar was added with thorough stirring till the dough became suitable to make peda balls of smooth consistency.

The effect of addition of whey protein concentrate (WPC) on sensory characteristics of peda was studied by Dewani and Jayaprakasha (2002) who reported that increasing the level of WPC upto 40% showed increasing color and appearance, body and texture and overall acceptability scores of peda whereas, flavor score increased even upto 50% level of addition.

In plain peda making process, prolonged heating of milk leads to severe browning and loss of nutritional quality. To overcome this problem reverse osmosis (RO) technology was adopted by Dewani and Jayaprakash (2006). They optimized the process of production of peda from RO pre-concentrated milk and vacuum evaporation. It involved standardization (5% milk fat and 8.5% MSNF) followed by heating of milk to 90 °C/10 min, pre-concentrating milk to 30% total solids (TS) by RO and further concentrating to 40% TS at 54 – 56 °C and a vacuum of 630 mm of Hg by using a single effect vacuum evaporator. This concentrated milk was used for peda making. It was reported that the color and appearance, body and texture scores of peda prepared from RO pre-concentrated milk improved appreciably.

### 3.4 Shelf life of Peda

Peda is expected to have good shelf life due to low moisture and high percentage of sugar. However, it is susceptible to microbial spoilage during manufacturing and handling and also due to surface contamination. The shelf life of peda under normal packaging conditions at room temperature is about 2 weeks. It can be increased to about 40 days by packaging in pre-sterilized shrink wrap. It was reported that replacement of 50% cane sugar with corn syrup reduced the water activity to about 0.6 and enhanced the shelf life upto 45
days in addition to improving the body and texture. Addition of 0.1% sorbic acid at the end of manufacturing process has also been found to extend the shelf life of peda upto 45 and 200 days at 30°C and 5°C respectively (Reddy, 1985). Ray, et. al, (1999) reported that addition of 0.05% of sorbic acid to peda extended the shelf life to 60 days at 7 ± 1°C.

Packaging of peda samples in multilayer transparent laminates with oxygen scavenger extended the shelf life upto 2 months at 37°C and 6 months at 20°C (Kumar, et. al, 1997). Sharma, et. al, (2003) studied the effect of modified atmosphere (MA) packaging on Malai peda and reported that the overall acceptability was found to be of superior quality at 11°C even after 31 days of storage.

Londhe (2006) had reported that the shelf life of brown peda packed in cardboard boxes, modified atmosphere packaging and vacuum packaging was found to be 20, 30 and 40 days respectively at 30 ± 1°C. Further it was reported that addition of 0.02% butylated hydroxyl anisole (BHA) and 0.1% potassium sorbate at the final stage of processing and vacuum packaging, increased the shelf life upto 50 and 60 days respectively at 30 ± 1°C.

4.0 Gulabjamun

Dhap khoa having 40-45% moisture is normally used for its preparation. Like other sweets, the manufacture of gulabjamun is also largely in the hands of halwais who adopt small scale batch method. Though there is large variations in the sensory quality of gulabjamun, the most liked product should have brown colour, smooth and spherical shape, soft and slightly spongy body free from both lumps and hard central core, uniform granular texture, mildly cooked and oily flavour, free from doughy feel and fully succulent with sugar syrup. It shall have optimum sweetness. The gross chemical composition of gulabjamun vary widely depending on numerous factors, such as, composition and quality of khoa, proportion of ingredients, sugar syrup concentration, etc. The composition of gulabjamun, on the drained weight basis varies from, moisture 25-35%, fat 8.5-10.5%, proteins 6-7.6% ash 0.9-1.0% and total carbohydrates 43.0-48.0%.

4.1 Traditional Method of Preparation

The traditional method of gulabjamun making from dhap khoa has been standardized by Ghosh et. al, (1986). It involves proper blending of 750 g khoa, 250 g refined wheat flour (maida) and 5 g baking powder to a homogenous and smooth dough. Small amount of water can be added in case dough is very hard and do not roll into smooth balls. The mix should be prepared fresh every time. The small balls formed from the dough are deep dried in ghee to golden brown colour and subsequently transferred to 60% sugar syrup maintained at about 60°C. It takes about 2 h for the balls to completely absorb the sugar syrup.

4.2 Mechanized Method of Preparation

A mechanized semi-continuous system is adopted for the manufacture of gulabjamun from khoa at Sugam Dairy, Baroda (Banerjee, 1997). The process involves mixing of khoa (60 – 70% TS) with 19 – 22% refined wheat flour and leavening agent (baking powder) in a planetary mixer. The dough is divided into 8 g portions and transported to the ball forming
machine. Then the balls are shaped like a cylinder and are carried to a frying system containing oil at a temperature of 140 °C. After frying, the balls are soaked in 62.5 percent sugar syrup solution. The glabjamuns swell and weigh about 16g each. The gulabjamuns are packed in plastic containers and an appropriate amount of hot syrup is added. Lids are applied on the cups and subsequently sealed. Packaged gulabjamuns are stored under refrigerated conditions. Canned gulabjamuns are stored at room temperature (Aneja, et. al, 2002).

4.3 Shelf life of Gulabjamun

The shelf life of gulabjamun at ambient temperature, in sugar syrup, is 5 – 7 days which can be extended to 3 weeks by hot filling in polystyrene cups and adding 0.1% potassium sorbate as a preservative. Canned gulabjamuns can be stored at room temperature (Aneja, et. al, 2002).

5.0 Rabri

Rabri is a partially concentrated and sweetened milk product containing several layers of clotted cream (Malai). It is quite popular in northern and eastern parts of the country. Traditionally, it is prepared by milk at a very small scale by simmering whole milk for a prolonged period and adding sugar after achieving the desired concentration. Rabri is generally manufactured and stored in open and shallow type of container which lead to enormous contamination from surroundings. The PFA and BIS have fixed no standards for rabri so far. Gayen and Pal, (1992 a) reported vide variation in the market samples of rabri.

5.1 Traditional Method of Manufacture

Based on the market survey, the desirable sensory and chemical attributes of rabri were characterized and a standard method of manufacture for rabri was developed (Gayen and Pal, 1991 b). It involves standardization of buffalo milk to 6% fat, its simmering in a steam jacketed kettle at 90 °C, repeated removal of clotted cream (Malai) on the colder part of the kettle or to a separate container, concentration of milk to three fold after removing about 100 gm clotted cream from 1 kg milk and adding sugar @ 6% of initial milk to the concentrated milk. The clotted cream is finally added to the concentrated sweetened milk.

5.2 Mechanized Method of Manufacture

Efforts have also been made to develop a commercial method for manufacture of rabri employing SSHE for concentration of buffalo milk, and addition of shredded chhana/paneer in place of clotted cream to provide the desirable texture to the final product (Gayen and Pal, 1991 b).

Pal, et. al, (2005) successfully developed a technology for the large scale production of rabri using thin film scraped surface heat exchanger (TSSHE). It involved standardization of buffalo milk to 6% fat, addition of sugar @ 6% to preheated (85 – 90 °C) milk and
concentrating in TSSHE upto 50% solids, addition of shredded paneer and packaging in hot condition (80 °C) and immediately cooling.

5.3 Shelf life of Rabri

Rabri prepared by traditional method and packaged in polystyrene cups has very limited shelf life of 16 hrs at 30 °C and about 18 days at 5 °C. The shelf life can marginally be increased by use of some permitted preservatives (Gayen and Pal, 1991 b). Pal, et. al, (2005) successfully attempted to enhance the shelf life of rabri prepared by large scale method. They reported that hot packaging (80 °C) followed by immediate cooling of rabri in PET bottles or glass bottles enhanced the shelf life to about 3 days at room temperature and 60 days at refrigeration storage (5 °C).

6.0 Conclusions

Heat desiccated traditional milk products delight the palate with their rich and distinctive aroma, flavor and taste. The traditional method of making these products by halwais encountered with some inherent problems such as large variations in chemical, sensory and rheological qualities, small scale batch operations, poor packaging and low shelf life. In order to overcome these problems, developments in the form of mechanization for large scale production, application of improved packaging methods, and incorporation of suitable food additives for shelf life enhancement have been achieved for some of the products. However, further research work is needed to bring the unexploited milk desserts into the gamut of heat desiccated milk products.

7.0 Suggested Readings


1.0 Introduction

Traditional milk products represent the most prolific segment of our Indian Dairy Industry. However, despite the widespread popularity and acceptability of traditional milk products in the Indian milieu, the organized sector has still not been able to fully trap their market potential for many reasons. Perhaps that is the reason that many traditional Indian dairy products are still not covered under various National Standards. The traditional dairy products that are covered under PFA rules are: khoa, paneer/chhana, ghee, dahi chakka, shrikhand and kulfi. The BIS has included burfi, gulabjamun, canned rasogolla and dahi in addition to those covered by PFA. AGRARK has prescribed standards only for ghee and butter. BIS has also defined the Code for hygienic conditions for production, transport, storage and distribution for these products.

A standard can be defined as a documented specification for properties of manufactured goods. It is a specification that has been worked out with scientific facts. The specifications are expressed in terms of some standard measurement units that are understandable and easy to follow. The enforcement of standard of particular food item gives the consumer a satisfaction that the product has defined specifications. Consumers around the world in general have the following concerns about food and most of these concerns can be addressed satisfactorily if there is a mechanism of enforcement of certain defined standards

1. Value for money is questionable
2. Adulteration and improper handling of foods lower nutritional quality
3. Information of the label is inadequate, not comparable and sometimes difficult to read
4. Doubts on the implementation of safety measures (good agricultural and manufacturing practices being adopted during handling of foods)
5. Lack of concern for environment
6. Doubts on the activities of enforcement agencies

In India we have many Acts/Order to have control on food items. Some are listed below:

- Preventions of Food Adulteration Act, 1954
- Fruits Product Order, 1955
- Milk and Milk Products Order, 1992
- Agricultural Produce (Grading & Marketing) Act, 1937
- Standards of Weights Measures Acts, 1976
- Packaging Commodities Rules, 1977
- BIS Certification (Mostly voluntary but some food products like SMP, food colours, etc. require compulsory certification)
- Export (Quality Control & Inspection) Act, 1963
- Consumer Protection Act, 1986

The standards specified in the above Acts/Orders are enforced through different agencies like the Central Government, State Government, Municipal Health Authorities etc. Sometimes the standards from one agency may not tally with the other resulting in improper implementation. To avoid all these problems Government of India has constituted a Committee to formulate a single food law. It is a difficult task since many ministries are involved but the industry is of the hope that one day this will become true. BIS certification for products is voluntary but under PFA, it is compulsory for some products. There are role of other regulatory agencies during processing of milk products. Table 1 gives an idea about such regulatory agencies.

Table 1: Regulatory Environment in the Dairy Processing Sector

<table>
<thead>
<tr>
<th>Compulsory Legislation</th>
<th>Voluntary Standards</th>
<th>Other Government Regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention of Food Adulteration Act, 1954</td>
<td>The Bureau of Indian Standards</td>
<td>Industrial license</td>
</tr>
<tr>
<td>Milk and Milk Products Order, 1992</td>
<td>Directorate of Marketing and Inspection</td>
<td>Foreign investment</td>
</tr>
<tr>
<td>Standards on Weights and Measures (Packaged Commodities) Rules, 1977</td>
<td></td>
<td>Foreign technology agreements</td>
</tr>
<tr>
<td>Export (Quality Control &amp; Inspection) Act, 1963</td>
<td></td>
<td>Import of capital goods</td>
</tr>
<tr>
<td>Packaging Commodities Rules, 1977</td>
<td>Import of second hand capital goods</td>
<td>Dividend balancing</td>
</tr>
<tr>
<td>Pollution Control</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As mentioned earlier, for the regulation of standards of traditional dairy products following agencies of the Government are involved

- Preventions of food Adulteration (PFA)
- Bureau of Indian Standards (BIS)
- Agriculture Marketing (AGMARK)

2.0 Preventions of Food Adulteration (PFA)

To safeguard the interest of the consumers and also the producers and distributors of food articles, in India, the Prevention of Food Adulteration Act was passed in 1954 by the
Parliament and the PFA Rules were framed which came into force on June 1, 1955. Different food articles have been defined accurately and the limits of the various analytical parameters specified. Any food falling outside the permissible ranges is considered substandard and is deemed to be adulterated. Convictions made under PFA Act are viewed seriously and invite legal punishment including heavy fines and non-bailable imprisonment.

The PFA Act is implemented by a countrywide network of Food Inspectors who collect at random samples suspected of having been adulterated. The sample is divided into three parts, and the specified quantity of preservative is added. The sample bottles/containers are then sealed and labeled. One sample is given to the vendor from whom it is drawn, one is retained as a reference and the third one is sent for analysis to the Public Health Laboratory. The Public Analyst performs the analysis according to specified procedures and gives his/her report. If the sample is found to be substandard with respect to any of the specified parameters, legal action is initiated against the vendor.

The standards are formulated and revised whenever required by an expert committee called Central Committee for Food Standards (CCFS).

Earlier, microbiological quality of the dairy products were not addressed in PFA. However, in the 11th Amendment (2005), microbiological standards have been defined for almost all the milk products including traditional dairy products. However, still some important aspects such as method of sampling, random sampling formula as suggested by BIS are not covered. Moreover, in penal clause, consideration is not given to the difference between the adulterated and substandard quality and the extent of adulteration.

3.0 Agmark Grading

Literally, AGMARK is an insignia – AG for ‘Agricultural’ and MARK for ‘marking’. Agricultural commodities do not normally conform to any specific standard but vary considerably and a strict control over their quality has to be maintained. In the case of product like ghee and butter there is a vast variation in quality and analytical parameter between the different regions of the country. These variations could arise due to the differences in crops, oil seeds, etc. used for feeding cattle. For example the Reichert Meissl (R.M) value of ghee produced in cotton tract areas like Saurashtra, etc. is much lower than the minimum permissible limits specified for normal ghee. In such cases there is a possibility of even pure ghee being rejected as adulterated. To overcome these problems and to ensure that the consumer gets a pure, unadulterated product, the Directorate of Marketing and Inspection introduced the quality control and standardization of ghee and butter in 1938. The grading of ghee under Agmark was introduced under the provisions of the Agricultural Produce (Grading and Marketing) Act, 1937. This act which is permissive in nature provides the grading of ghee and butter on a voluntary basis.

The Directorate of Marketing and Inspection (DMI) issues a certificate of authority to the packer after confirming that the product conform to the rigid quality specifications of the Agmark. The testing is done either at the producer’s own established laboratory or at the State Grading Laboratory by a panel of chemists approved by the Directorate of Marketing
and Inspection. After the ghee is packed, labeled and marketed, samples may be drawn occasionally from the market and tested at the Regional Analytical Laboratory.

Ghee is graded either as Special’ and ‘General’, which are represented by two differently coloured labels. The only difference in the grades is in the maximum limit of free fatty acids (oleic), which in special grade (Red label) ghee is limited to 1.4% and in general grade (Green label) to 2.5%. The other parameters defined are butyro-refractometer reading at 40°C, moisture content, Reichert-Meissl value, Polenske value, Baudouin test etc.

Similarly, two grades of butter viz., pasteurized table butter and unpasteurized table butter have been prescribed on the basis of flavour, aroma, body and texture, colour, moisture content, acidity curd, etc.

4.0 Bureau of Indian Standards

Bureau of Indian Standards (earlier ISI) had started the work with respect to formulation of standards for various food products since its inception in 1947. Indian Standards are formulated by the technical committee comprising experts from the Industry, Govt. departments, testing laboratories, users and consumers. National Standards are evolved through a consensus opinion of the members comprising of a technical committee. In this context, the Bureau of Indian Standards, which is the national organization for standardization in our country, has so far formulated over 16000 Indian Standards.

Food has always been a priority of BIS for standardization. Food and Agricultural & Food Products Division (FAD) of the BIS are working since 1956. Out of 15 Sectional Committees dealing with Food under FAD, the technical committee FAD-57 which deals with Dairy Products and equipment has so far published 116 Standards on the subject. Many dairy products such as pasteurized milk, milk powder, skim milk powder, condensed milk, infant milk food, cheeses etc., are widely used by the consumers in their day to day life. There are many indigenous milk products for which the standards have been formulated under BIS (Table 1). Many of these milk products have standards only as per BIS and PFA has still not formulated standards for such indigenous milk products.

BIS has published Indian Standards for all the above products to take care of the quality as well as safety and health aspects of the consumers. Such standards also emphasize on the requirement of hygienic conditions to be maintained during storage of raw materials, manufacturing and processing, packaging and storage of the food products. One advantage with BIS standard is that, these standards are complete in every sense as they even mention the analytical methods to be followed for testing of such milk products. BIS has also defined Code for hygienic conditions for production, transport, storage and distribution of some indigenous milk products such as khoa & khoa based sweets, channa & channa based sweets, dahi, kulfi and shrikhand.

BIS also operates a Certification Marks Scheme under the BIS Act, 1986 to help the consumer identify the quality of which is assured by the Bureau. Under the scheme, interested manufactures are granted licenses to mark their products with the Bureau’s Standard Mark known as ISI after the Bureau satisfies itself to that affect.
5.0  Codex Standards and Traditional Dairy Products

The different sets of standards arising from the spontaneous and independent development of food laws and standards by different countries inevitably gave rise to trade barriers that were of increasing concern to food traders in the early twentieth century. Trade associations that were formed as a reaction to such barriers pressured governments to harmonize their various food standards so as to facilitate trade in safe foods of a defined quality. The International Dairy Federation (IDF), founded in 1903, was one such association. Its work on standards of milk and milk products later provides a catalyst in the establishment of Codex Alimentarius Commission and in the setting of its procedures for elaborating standards.

The Codex Alimentarius Commission is responsible for making proposals to, and shall be consulted by, the Director-General of the Food and Agricultural Organization (FAO) and the World Health Organization (WHO) on all matters pertaining to the implementation of the joint FAO/WHO Standard Programme.

In addition to commodity standards, the Codex Alimentarius include general standards, which has across-the-board application to all foods and are not product specific. There are general standards or recommendations for:

- Food Labeling
- Food Additives
- Contaminants
- Method of analysis and sampling
- Food hygiene
- Nutrition and foods for special dietary uses
- Food import and export inspection and certifications systems
- Residues of veterinary drugs in foods
- Pesticide residues in foods.

Although it is still a distant dream that traditional dairy products may find suitable place in the listing of Codex Standards as commodity standards, general standards may be followed for the harmonization purpose. For export purposes, general standards listed above can be adopted.

6.0  Integrated Food Law on the Government’s Agenda

The Union Ministry for Food Processing Industries is ready with a draft of an integrated food law (by integrating all the Acts) that will replace the laws that regulate the sector at present. The Centre had constituted a group of ministers (GoM) to formulate a single law for food processing industries under the chairmanship of Union Agriculture Minister. All efforts have been made to ensure that Integrated Food Law should be formed in a time bound manner with a single food law and single regulatory agency approach. This Bill with its three tier structure (An apex Food Safety and Standards Authority, a Central Advisory Committee under it and various scientific panels and Committees) is expected to
lay more emphasis on science based and participatory decisions and adopting contemporary approach in both standard setting and implementation. The bill (Food Safety and Standards Bill 2005) has been passed both in Lok Sabha and Rajya Sabha and has taken the shape of an Act (Food Safety and Standards Act 2005). Besides aiming to end the Inspector Raj in the sector, the legislation empowers consumers to lift the sample of any suspected food item available in the market and send it to a laboratory for testing. The Bill has been signed by the President of India and now cabinet will decide whether it will be implemented through Ministry of Food Processing or Ministry of Health.

7.0 Conclusion

India’s traditional dairy sector is poised for rapid expansion with the result of application of modern process technologies in the production of Indian sweets. The need of the market will determine the change in technology that will be required in the future. Fast changes in socio-economic environment will drive the requirements for traditional dairy products to be processed and packaged in new forms. Although demand for traditional dairy products far exceed that of western type of dairy products, it present only handful of the traditional dairy products are covered under various standards. The role of standards in supporting and facilitating the smooth functioning of the chain of processes and also embedding quality in the system cannot be underestimated. Standard provide the needed guidelines to the entrepreneurs in ensuring the right practices to be followed during various stages, such as storage, transportation, selection of raw material, processing and packing and also pinpoint the specifications which should be adhered to, in order to promote quality and safety of the end product. So for integrated speedy development of dairy sector, standardization has a vital role to play.
Annexure – I

Compositional Standards of Various Traditional Dairy Products

1. KHOA

**PFA specifications:** By whatever variety of names it is sold such as Pindi, Danedar, Dhap, Mawa or kava means the product obtained from cow or buffalo or goat or sheep milk or milk solids or a combination thereof by rapid drying. The milk fat content shall not be less than 30.0% on dry weight basis of the finished product. It may contain citric acid not more than 0.1% by weight. It shall be free from added starch, added sugar and added coloring matter.

**BIS specifications:** As per BIS, Khoa as presently being marketed is designated as Pindi, Danedar and Dhap.

| Table – 1: Chemical and microbiological requirements for Khoa as per PFA and BIS |
|----------------------------------|-------------------------------|
| **Characteristic**               | **Requirements for Khoa**     |
|                                  | **PFA**                       |
|                                  | **BIS (IS:4883-1980, Reaffirmed 1999)** |
|                                  | **Pindi** | **Danedar** | **Dhap** |
| Total solids, % by mass, *Min*   | -         | 65.0        | 60.0     | 55.0     |
| Milk fat, % by mass, (on dry basis), *Min* | 30         | 37          | 37       | 37       |
| Total ash, % by mass (on dry basis), *Max* | -         | 6.0         | 6.0      | 6.0      |
| Titratable acidity (as lactic acid), % by mass, *Max* | -         | 0.8         | 0.9      | 0.6      |
| **Food Additives**               |                               |
| 1. May contain citric acid not more than 0.1% by wt. | -         |
| 2. Shall be free from added starch, added sugar and added colouring matter | -         |
| Total Plate Count                | Not more than 50,000/g         |
| Coliform count, per g, *Max*     | 90                             |
| E. coli                         | Absent in 1 g                  |
| Salmonella                      | Absent in 25 g                 |
| Shigella                        | Absent in 25 g                 |
| *Staphylococcus aureus*         | Not more than 100/g            |
| Yeast and mould count           | 250 per g, max                 | 50 per g, max |

*Note: *Min = Minimum, *Max = Maximum.
<table>
<thead>
<tr>
<th>Anaerobic spore count</th>
<th>Absent in 1 g</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>Absent in 1 g</td>
<td>-</td>
</tr>
</tbody>
</table>

2. **BURFI**

**BIS specification:** BIS has classified different varieties of burfi sold in the market into following three types

1. Milk or mawa burfi containing mainly khoa and sugar with or without added colouring and flavouring materials;
2. Fruit, nut, chocolate or cocoa burfi containing khoa, sugar and the special ingredient; and
3. Rava burfi containing khoa, sugar and rava together with flavoring or colouring material.

<table>
<thead>
<tr>
<th>Table – 2: BIS Requirements for burfi</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristic</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Moisture, % by mass, <em>Max</em></td>
</tr>
<tr>
<td>Milk fat, % by mass, <em>Min</em></td>
</tr>
<tr>
<td>Lactose, % by mass, <em>Min</em></td>
</tr>
<tr>
<td>Titratable acidity (as lactic acid), % by mass, <em>Max</em></td>
</tr>
<tr>
<td>Sucrose, % by mass, <em>Max</em></td>
</tr>
<tr>
<td>Standard place count per g, <em>Max</em></td>
</tr>
<tr>
<td>Yeast and mould count, per g, <em>Max</em></td>
</tr>
</tbody>
</table>

* Food additives like anti-oxidants, preservatives, food colours and flavouring essences added shall be those permitted under the prevention of Food Adulteration Rules, 1955.
* Dried fruits and nuts, fruit juices (fresh, canned or concentrated) added to burfi should conform to the requirements of Fruit Products Order, 1955.

3. **GULABJAMUN**

**BIS Specifications:** Gulabjamun shall be prepared from khoa, skim milk powder, milk powder, ghee, cream, butter or other milk solids. It may contain maida (wheat flour), citric acid and baking powder. It shall be free from dirt and other foreign matter as well as insects and mould growth. It should be, as far as possible, manufactured and packed under hygienic conditions. The proportion of free syrup in a gulabjamun pack shall not exceed 60% of the declared net mass.
Table – 3: Compositional specifications for Packed Gulabjamun as per BIS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirements for Gulabjamun (IS: 11602: 1986, Reaffirmed 1997)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture, % by mass, Max</td>
<td>30.0</td>
</tr>
<tr>
<td>Fat, % by mass, Min</td>
<td>8.0</td>
</tr>
<tr>
<td>Protein, % by mass, Min</td>
<td>8.0</td>
</tr>
<tr>
<td>Concentration of sugar in syrup, % by mass, Min</td>
<td>40.0</td>
</tr>
<tr>
<td>Bacterial count, per g, Max</td>
<td>3000</td>
</tr>
<tr>
<td>Coliform count, per g, Max</td>
<td>50</td>
</tr>
<tr>
<td>Yeast and mould count, per g, Max</td>
<td>50</td>
</tr>
</tbody>
</table>

Requirements for sugar syrup

The sugar syrup shall be clear and light to golden yellow in colour, and shall conform to the requirements given in the table as follows. The proportion of free syrup in a gulab jamun pack shall not exceed 60% of the declared net mass. There should not be excessive free fat floating in the syrup or adhering to gulab jamun pieces. The package should not also contain broken pieces of gulab Jamuns in the syrup.

Table - 3a: Requirements for sugar syrup as per BIS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirements for sugar syrup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity of syrup, ml of 0.1 N NaOH required to neutralize 100 ml of the syrup, Max</td>
<td>6.0</td>
</tr>
<tr>
<td>Concentration of syrup, Min</td>
<td>62.4° Brix</td>
</tr>
<tr>
<td>Bacterial count, per g, Max</td>
<td>5000</td>
</tr>
<tr>
<td>Coliform count, per g, Max</td>
<td>50</td>
</tr>
</tbody>
</table>

4. CHHANA

PFA specifications: Chhana means the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70.0% moisture and the milk fat content shall not be less than 50.0% of the dry matter. Milk solids may also be used in the preparation of this product.
In chhana, either sorbic acid and its sodium, potassium and calcium salts or propionic acid and its sodium and potassium salts may be added up to the extent of 2000 mg/kg.

**BIS specifications:** BIS has formulated standards for skim milk chhana and whole milk chhana. The fat percentage of milk shall be such that the final product conforms to the requirements given in the Table 4

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirements for Chhana</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PFA</strong></td>
<td><strong>BIS</strong> (IS: 5162:1980, Reaffirmed 1999)</td>
</tr>
<tr>
<td>Chhana</td>
<td>Chhana</td>
</tr>
<tr>
<td>Max 70.0</td>
<td>Max 65.0</td>
</tr>
<tr>
<td>Skim milk Chhana</td>
<td>Max 60.0</td>
</tr>
<tr>
<td>15.0 (Max)</td>
<td>5.0 (Max)</td>
</tr>
</tbody>
</table>

**Food Additives**

1. Sorbic acid, Na/K/Ca sorbate expressed as sorbate –2000 mg/kg, max
2. Propionic acid, Na/Ca propionate expressed as propionic acid- singly or in combination –2000 mg/kg, max
3. Nisin 12.5 mg/kg, max

No extraneous colouring matter shall be added to chhana

| *Shall be sold in sealed pack only.*

**5. PANEER**

**PFA specifications:** Paneer means the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70.0% moisture and the milk fat content shall not be less than 50.0% of the dry matter. Milk solids may also be used in the preparation of this product. In paneer,
either sorbic acid and its sodium, potassium and calcium salts or propionic acid and its sodium and potassium salts may be added up to the extent of 2000 mg/kg.

**BIS specifications:** An important indigenous milk product prepared by the combined action of acid coagulation and heat treatment of buffalo or cow milk or a combination thereof (milk solids suitably processed may also be used). Paneer shall be clear and free from dirt, surface discolouration, insects and rodents contamination and from adulterants. It shall not have any free moisture. Paneer shall have a pleasant odour and characteristic milk acidic flavour. It shall have a closely knit smooth texture, firm, cohesive and spongy body. Before coagulation, milk shall be boiled or heated to a sufficiently high temperature for such time that it will result in the complete destruction of pathogenic microorganisms.

The coagulants such as lactic acid, citric acid and their sodium and potassium salts shall be of food grade and free from toxic substances. The sour whey shall be heat-treated to render it microbiological safe.

**Table – 5: Chemical and microbiological requirements for Paneer as per BIS**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>PFA</th>
<th>BIS (IS: 10484-1983, Reaffirmed 1999)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paneer</td>
<td>Low fat Paneer*</td>
</tr>
<tr>
<td>Moisture, % by mass, Max</td>
<td>70.0</td>
<td>70.0</td>
</tr>
<tr>
<td>Milk fat, % by mass, (on dry basis)</td>
<td>50.0 (Min)</td>
<td>15.0 (Max)</td>
</tr>
<tr>
<td>Titratable acidity (as lactic acid), % by mass, Max</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Plate Count</td>
<td>Not more than 50,000/g</td>
<td>Not more than 50,000/g</td>
</tr>
<tr>
<td>Coliform count, per g, Max</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>E. coli</td>
<td>Absent in 1 g</td>
<td>-</td>
</tr>
<tr>
<td>Salmonella</td>
<td>Absent in 25 g</td>
<td>-</td>
</tr>
<tr>
<td>Shigella</td>
<td>Absent in 25 g</td>
<td>-</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>Not more than 100/g</td>
<td>-</td>
</tr>
<tr>
<td>Yeast and mould count, per g, Max</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Anaerobic spore count</td>
<td>Absent in 1 g</td>
<td>-</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>Absent in 1 g</td>
<td>-</td>
</tr>
<tr>
<td><strong>Food Additives</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Sorbic acid, Na/K/Ca sorbate expressed as sorbate –2000 mg/kg, max</td>
<td>1. Sorbic acid, Na/K/Ca sorbate expressed as sorbate –2000 mg/kg, max</td>
<td></td>
</tr>
<tr>
<td>2. Propionic acid, Na/Ca propionate expressed as propionic acid- singly or in combination –2000 mg/kg, max</td>
<td>2. Propionic acid, Na/Ca propionate expressed as propionic acid- singly or in combination –2000 mg/kg, max</td>
<td></td>
</tr>
<tr>
<td>3. Nisin 12.5 mg/kg, max</td>
<td>3. Nisin 12.5 mg/kg, max</td>
<td></td>
</tr>
</tbody>
</table>

* Shall be sold in sealed pack only.
6. RASOGOLLA

Only BIS has specified standards for rasogolla which should be packed in cans.

**BIS Specifications:** Canned rasogolla shall be prepared from channa obtained from clean, fresh and sweet milk. It shall be white or light creamy in colour. It shall be free from dirt and other foreign matter as well as insect and mould growth. It should be, as far as possible, manufactured and packed under hygienic conditions. Rasogolla to syrup ratio in the container shall be about 2:3. The product shall also comply with the requirements given in the tables as below.

<table>
<thead>
<tr>
<th>Table – 6: Compositional specifications for canned Rasogolla as per BIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristic</strong></td>
</tr>
<tr>
<td>Moisture, % by mass, <em>Max</em></td>
</tr>
<tr>
<td>Fat, % by mass, <em>Min</em></td>
</tr>
<tr>
<td>Protein, % by mass, <em>Min</em></td>
</tr>
<tr>
<td>Sucrose, % by mass, <em>Max</em></td>
</tr>
</tbody>
</table>

N.B. As per PFA, *Sulphur dioxide – 100 ppm, max may be added as preservative. The cans shall be internally lacquered with sulphur dioxide resistant lacquer*

<table>
<thead>
<tr>
<th>Table 6a: Requirements for sugar syrup of canned Rasogolla as per BIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristic</strong></td>
</tr>
<tr>
<td>Acidity of syrup, ml of 0.1 N NaOH required to neutralize 100 ml of the syrup, <em>Max</em></td>
</tr>
<tr>
<td>Concentration of syrup, <em>Max</em></td>
</tr>
<tr>
<td>Bacterial count, per g, <em>Max</em></td>
</tr>
<tr>
<td>Coliform count, per g</td>
</tr>
</tbody>
</table>

7. CHAKKA AND SHRIKHAND

**PFA Specifications:** Chakka means a white to pale yellow semi-solid product of good texture and uniform consistency obtained by draining off the whey from the yoghurt obtained by the lactic fermentation of cow’s milk, buffaloes milk, skimmed milk and recombined or standardized milk which has been subjected to minimum heat treatment equivalent to that of pasteurization. It shall have pleasant yoghurt or dahi like flavour. It shall not contain any ingredient foreign to milk. It shall be free from mouldness and free from signs of fat or water seepage or both. It shall be smooth and it shall not appear dry. It shall not contain extraneous colour and flavours.

Shrikhand means the product obtained from chakka or skimmed milk chakka to which milk fat is added. It may contain fruits, nuts sugar, cardamom, saffron and other spices. It shall not contain any added colouring and artificial flavouring substances. Chakka and Shrikhand shall conform to the specifications mentioned in Table 7.
Table – 7: PFA & BIS requirements for Chakka and Shrikhand

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>PFA*</th>
<th>BIS (IS: 9532-1980, Reaffirmed 1999)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chakka*</td>
<td>Skim milk chakka</td>
<td>Shrikhand**</td>
</tr>
<tr>
<td>Total solids, % by weight, \textit{Min}</td>
<td>30.0</td>
<td>20.0</td>
<td>58.0</td>
</tr>
<tr>
<td>Milk fat (on dry basis), % by weight</td>
<td>33.0, \textit{Min}</td>
<td>5.0, \textit{Max}</td>
<td>8.5 \textit{Min}</td>
</tr>
<tr>
<td>Milk protein (on dry basis), % by weight, \textit{Min}</td>
<td>30.0</td>
<td>60.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Titratable acidity (as lactic acid), % by weight, \textit{Max}</td>
<td>2.5</td>
<td>2.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Sugar (sucrose) (on dry basis), % by weight, \textit{Max}</td>
<td>-</td>
<td>-</td>
<td>72.5</td>
</tr>
<tr>
<td>Total ash (on dry basis), % by weight, \textit{Max}</td>
<td>3.5</td>
<td>5.0</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**Food Additives**

*It shall not contain any added colouring and artificial flavouring substances*

<table>
<thead>
<tr>
<th></th>
<th>No artificial colouring material should be added to chakka &amp; shrikhand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Plate Count</td>
<td>Not more than 50,000/g</td>
</tr>
<tr>
<td>Coliform count, per g, Max</td>
<td>-</td>
</tr>
<tr>
<td>E. coli</td>
<td>Absent in 1 g</td>
</tr>
<tr>
<td>Salmonella</td>
<td>Absent in 25 g</td>
</tr>
<tr>
<td>Shigella</td>
<td>Absent in 25 g</td>
</tr>
<tr>
<td>\textit{Staphylococcus aureus}</td>
<td>Not more than 100/g</td>
</tr>
<tr>
<td>Yeast and mould count, per g, Max</td>
<td>10</td>
</tr>
<tr>
<td>Anaerobic spore count</td>
<td>Absent in 1 g</td>
</tr>
<tr>
<td>\textit{Listeria monocytogenes}</td>
<td>Absent in 1 g</td>
</tr>
</tbody>
</table>

*Chakka when sold without any indication shall conform to the standards of chakka.

** As per PFA, in case of Fruits Shrikhand, it shall contain milk fat (on dry basis) % by wt. – not less than 7.0 and milk protein (on dry basis) % by wt. – not less than 9.0.
**BIS specifications:** For the preparation of chakka, only fresh, sweet clean milk (cow or buffalo), fresh skimmed milk, reconstituted skimmed milk, recombined milk, or standardized milk, in every way fit for human consumption shall be used. The milk shall be free from adulterants, preservatives and any matter foreign to milk. The fat percentage of milk other than skimmed milk and reconstituted skimmed milk shall be such that the final product conforms to the requirements given in the above Table 7. Chakka shall not contain any ingredient foreign to milk. Shrikhand should not contain any ingredient foreign to milk except those permitted. The product should not be too thick or too thin and its consistency should be very smooth. There should not be any syrup pockets or separation in the body of the shrikhand.

**8. DAHI**

**PFA Specifications:** Dahi or curd means the product obtained from pasteurized or boiled milk by souring, natural or otherwise, by a harmless lactic acid or other bacterial culture. Dahi may contain added cane sugar. Dahi shall have the same minimum percentage of milk fat and milk solids-not-fat as the milk from which it is prepared. Where dahi or curd is sold or offered for sale without any indication of class of milk, the standards prescribed for dahi prepared from buffalo milk shall apply. Milk solids may also be used in the preparation of this product.

**BIS specifications:** As per BIS (IS 9617-1980), dahi has been classified into following two types:

1. Plain dahi
2. Flavoured dahi

The following culture shall be used in the preparation of dahi

a. *Streptococcus lactis*, *Streptococcus diacetylactis*, *Streptococcus cremoris*, single or in combination with or without *Leuconostoc* species; and

b. Also as above along with species of *Lactobacillus* such as *Lactobacillus bulgaricus*, *Lactobacillus acidophilus* and *Lactobacillus casei* and *Streptococcus thermophilus*.

**Food Additives:** The following may be added to dahi provided these additions do not exceed 25% by mass of the final product

- Sugar may be added according to the requirements of consumer.
- Flavouring essences shall be selected from those permitted under the PFA Rules, 1955.
- Flavoured extracts and various artificial flavours shall be pasteurized at 63°C for 30 min before use.
- Stabilizers permitted under the PFA Rules, 1955, when used, shall not exceed 0.2% by mass of the product.
- The addition of sugar and stabilizers may be done prior to heat treatment of the milk but stabilizers may be added even after partial fermentation of the milk.
### Table – 8: PFA and BIS requirements for Dahi

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>PFA</th>
<th>BIS (IS 9617-1980, Reaffirmed 1999)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity, as lactic acid, % by mass</td>
<td>-</td>
<td>0.6 to 0.8</td>
</tr>
<tr>
<td>Total Plate Count</td>
<td>Not more than 10,00,000/g</td>
<td>-</td>
</tr>
<tr>
<td>Coliform count</td>
<td>10 per g, max</td>
<td>10 per g, max</td>
</tr>
<tr>
<td>E. coli</td>
<td>Absent in 1 g</td>
<td>-</td>
</tr>
<tr>
<td>Salmonella</td>
<td>Absent in 25 g</td>
<td>-</td>
</tr>
<tr>
<td>Shigella</td>
<td>Absent in 25 g</td>
<td>-</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>Not more than 100/g</td>
<td>-</td>
</tr>
<tr>
<td>Yeast &amp; mould count,</td>
<td>100 per g, max</td>
<td>100 per g, max</td>
</tr>
<tr>
<td>Anaerobic spore count</td>
<td>Absent in 1 g</td>
<td>-</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>Absent in 1 g</td>
<td>-</td>
</tr>
<tr>
<td>Phosphatase test</td>
<td>-</td>
<td>Negative</td>
</tr>
</tbody>
</table>

**Other requirements**

- Dahi shall have the same minimum percentage of milk fat and milk-solids-not-fat as the milk from which it is prepared
- Where dahi or curd is sold or offered for sale without any indication of class of milk, the standards prescribed for dahi prepared from buffalo milk shall apply

**Other requirements**

- Dahi shall conform to the requirements of milk fat and milk solids-not-fat, as laid down in PFA Rules, 1955

**Food Additives**

- See BIS requirements in the text

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**9. KULFI**

**PFA specifications:** Earlier, PFA has specified different requirements/standards for ice-cream and kulfi. Now, for both kulfi and ice-cream, same requirements/standards has been specified. Kulfi means the product obtained by freezing a pasteurized mix prepared from milk and/or other products derived from milk with the addition of nutritive sweetening agents e.g. sugar, dextrose, fructose, liquid glucose, dried liquid glucose, maltodextrin, high maltose corn syrup, honey, fruit and fruit products, eggs and egg products, coffee, cocoa, ginger and nuts. It may also contain chocolate, and bakery products such as cake, or cookies as a separate layer and/or coating. It may be frozen hard or frozen to a soft consistency. It shall be free from artificial sweeteners. It shall have pleasant taste and smell free from off flavour and rancidity. It shall conform to following requirements.
**BIS specifications:** Kulfi means the frozen product obtained from cow or buffalo milk or a combination thereof or from any other milk products, with or without the addition of cane sugar, dextrose, liquid glucose and dried liquid glucose, eggs, fruits, fruit juices, preserved fruits, nuts, chocolates, edible flavours and permitted food colours. The product shall have a pleasant agreeable aroma and taste with uniform consistency, free from big sized crystals and coagulated milk particles. Kulfi shall be free from dust and such other foreign material. Kulfi shall be frozen in an ice-salt mixture (ice & salt; 4:1) in an earthen pot or other suitable vessel with intermittent stirring of the freezing mixture.

No fat other than milk fat shall be present in the product with the exception of that derived from eggs, cocoa, nuts and emulsifiers (monoglycerides) if added to kulfi. The product shall not contain any added starch. The permitted stabilizers and emulsifiers if used shall not be more than 0.5% by weight. Coloring matter and flavoring agent as permitted under PFA Rule, 1955 may be added. The colour and the flavour to be added may be as desired by the purchaser. No chemical preservative shall be present in kulfi.

**Table – 9: Compositional standards of Kulfi as per PFA & BIS specifications**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement for Kulfi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Ice-cream</strong></td>
</tr>
<tr>
<td>Total solids, % by mass, Min</td>
<td>36.0</td>
</tr>
<tr>
<td>Wt/Vol (gms/L), Min</td>
<td>525</td>
</tr>
<tr>
<td>Milk fat, % by mass</td>
<td>10.0, Min</td>
</tr>
<tr>
<td>Protein, % by mass, Min</td>
<td>3.5</td>
</tr>
<tr>
<td>Acidity (as lactic acid), % by mass, Max</td>
<td>-</td>
</tr>
<tr>
<td>Sucrose, % by mass, Min</td>
<td>-</td>
</tr>
<tr>
<td>Additives</td>
<td>-</td>
</tr>
<tr>
<td>Carrageenan</td>
<td>10 g/kg, Max</td>
</tr>
<tr>
<td>Pectins</td>
<td>10 g/kg, Max</td>
</tr>
<tr>
<td>Sodium carboxy methyl cellulose</td>
<td>10 g/kg, Max</td>
</tr>
<tr>
<td>Agar</td>
<td>10 g/kg, Max</td>
</tr>
<tr>
<td>Guar gum</td>
<td>10 g/kg, Max</td>
</tr>
<tr>
<td>Ingredient</td>
<td>Specification</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Xanthan gum</td>
<td>10 g/kg, Max</td>
</tr>
<tr>
<td>Furcellaran</td>
<td>10 g/kg, Max</td>
</tr>
<tr>
<td>Propylene glycol alginate</td>
<td>10 g/kg, Max</td>
</tr>
<tr>
<td>Sucralose (Artificial sweetener)</td>
<td>400 ppm, max</td>
</tr>
<tr>
<td>Total colony count per g (standard plate count), Max</td>
<td>250,000</td>
</tr>
<tr>
<td>Coliform count per g, Max</td>
<td>10</td>
</tr>
<tr>
<td>E. coli</td>
<td>Absent in 1 g</td>
</tr>
<tr>
<td>Salmonella</td>
<td>Absent in 25 g</td>
</tr>
<tr>
<td>Shigella</td>
<td>Absent in 1 g</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>Absent in 1 g</td>
</tr>
<tr>
<td>Yeast and mold count</td>
<td>Absent in 1 g</td>
</tr>
<tr>
<td>Anaerobic spore count</td>
<td>Absent in 1 g</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>Absent in 1 g</td>
</tr>
<tr>
<td>Phosphatase test of mix</td>
<td>-</td>
</tr>
</tbody>
</table>

10. GHEE

**PFA specifications:** Ghee means the pure clarified fat derived solely from milk or curd or from deshi (cooking butter) or from cream to which no colouring matter or preservative has been added. The standards for the quality of ghee produced in a state/union territories are given in the Table 10.

<table>
<thead>
<tr>
<th>Table – 10: Standards of ghee under PFA rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the State &amp; U.T.</td>
</tr>
<tr>
<td>Bihar, Chandigarh, Delhi, Punjab, Haryana (Areas other than cotton tract areas), West Bengal (Areas other than cotton tract), Sikkim</td>
</tr>
<tr>
<td>BR Reading at 40°C</td>
</tr>
</tbody>
</table>
R M Value, Min   28  26  26  24  24  24  21
% FFA (as Oleic acid), Max  3  3  3  3  3  3  3
% Moisture, Max  0.5  0.5  0.5  0.5  0.5  0.5  0.5
SPC  250,000 per g, max
Coliform count  10 per g, max
E.coli  Absent in 1 g
Salmonella  Absent in 25 g
Shigella  Absent in 1 g
Staphylococcus aureus  Absent in 1 g
Yeast & mold count  Absent in 1 g
Anaerobic spore count  Absent in 1 g
Listeria monocytogenes  Absent in 1 g

a) Baudouin test shall be negative
b) By cotton tract is meant the areas in the state where cotton seed is extensively fed to the cattle and so notified by the State Govt. concerned.
c) Usually such cotton tract areas ghee has low RM value and high BR reading compared to other areas
d) Ghee may contain BHA not more than 0.02% as antioxidant.

<table>
<thead>
<tr>
<th>Physico-chemical constants</th>
<th>Areas other than cotton tract</th>
<th>COTTON tract areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Special</td>
<td>General</td>
</tr>
<tr>
<td>Baudouin Test</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Butyro-refractometer reading at 40°C</td>
<td>40.0-43.0</td>
<td>40.0-43.0</td>
</tr>
<tr>
<td>Reichert Meissl value</td>
<td>Not less than 28.0</td>
<td>Not less than 28.0</td>
</tr>
<tr>
<td>Polenske value</td>
<td>1.0-2.0</td>
<td>1.0-2.0</td>
</tr>
<tr>
<td>Moisture content</td>
<td>Not more than 0.3%</td>
<td>Not more than 0.3%</td>
</tr>
<tr>
<td>% FFA (as oleic acid)</td>
<td>Not more than 1.4</td>
<td>Not more than 2.50</td>
</tr>
</tbody>
</table>

* Ghee with Reichert Meissl value between 19 and 21 shall be graded only after Phytosteryl Acetate Test has been performed and the results thereof found to be negative.
N.B. Percentage of FFA (as oleic acid) shall not exceed 3.0 for Standard Grade Ghee
### Annexure – 2.


<table>
<thead>
<tr>
<th>Pesticide</th>
<th>MRL of pesticide residues in milk as per CAC(^{\text{a}}), 2006</th>
<th>MRL of pesticide residues in milk &amp; milk products as per PFA, 2006</th>
<th>ADI (mg/kg body wt) as per CAC, 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldrin and dieldrin</td>
<td>0.006(F)</td>
<td>0.15*</td>
<td>0.0001</td>
</tr>
<tr>
<td>Benomyl</td>
<td>N</td>
<td>0.10*</td>
<td>N</td>
</tr>
<tr>
<td>Carbendazim</td>
<td>N</td>
<td>0.10*</td>
<td>N</td>
</tr>
<tr>
<td>Carbofuran</td>
<td>0.05(#)**</td>
<td>0.05*</td>
<td>N</td>
</tr>
<tr>
<td>Chlordane</td>
<td>0.002(F)</td>
<td>0.05*</td>
<td>0.0005</td>
</tr>
<tr>
<td>Chlorfenvinphos</td>
<td>N</td>
<td>0.2*</td>
<td>N</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>0.02</td>
<td>0.01*</td>
<td>0 - 0.01</td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>0.05(F)</td>
<td>0.01*</td>
<td>N</td>
</tr>
<tr>
<td>DDT</td>
<td>0.02(F)</td>
<td>1.25*</td>
<td>0.01</td>
</tr>
<tr>
<td>Dimethoate</td>
<td>0.05(#)**</td>
<td>N</td>
<td>0.002</td>
</tr>
<tr>
<td>2,4 D</td>
<td>0.01</td>
<td>0.05**</td>
<td>0.01</td>
</tr>
<tr>
<td>Ethion</td>
<td>N</td>
<td>0.5**</td>
<td>0.002</td>
</tr>
<tr>
<td>Edifenphos</td>
<td>N</td>
<td>0.01*</td>
<td>N</td>
</tr>
<tr>
<td>Fenithion</td>
<td>N</td>
<td>0.05*</td>
<td>0.007</td>
</tr>
<tr>
<td>Fenitrothion</td>
<td>0.002(#)**</td>
<td>0.05*</td>
<td>0 - 0.005</td>
</tr>
<tr>
<td>Fenvalerate</td>
<td>0.1(F)</td>
<td>0.01*</td>
<td>N</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>0.006(F)</td>
<td>0.15*</td>
<td>0.0001</td>
</tr>
<tr>
<td>Hexachlorocyclohexane (HCH)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\alpha)-Isomer</td>
<td>N</td>
<td>0.05***</td>
<td>N</td>
</tr>
<tr>
<td>(\beta)-Isomer</td>
<td>N</td>
<td>0.02***</td>
<td>N</td>
</tr>
<tr>
<td>(\gamma)-Isomer (Lindane)</td>
<td>0.01(#)</td>
<td>0.01***</td>
<td>0.005</td>
</tr>
<tr>
<td>(\delta)-Isomer</td>
<td>N</td>
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<td>0.20+</td>
</tr>
<tr>
<td>Paraquat</td>
<td>0.01(#)**</td>
<td>0.01**</td>
<td>0 - 0.005</td>
</tr>
<tr>
<td>Monocrotophos</td>
<td>N</td>
<td>0.02**</td>
<td>0.0006</td>
</tr>
<tr>
<td>Parathion</td>
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<td>N</td>
<td>0.004</td>
</tr>
<tr>
<td>Phorate</td>
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</tr>
<tr>
<td>Pirimiphos-methyl</td>
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<td>0.05*</td>
<td>N</td>
</tr>
<tr>
<td>Phenthoate</td>
<td>N</td>
<td>0.01*</td>
<td>N</td>
</tr>
<tr>
<td>Trichlorfon</td>
<td>N</td>
<td>0.05**</td>
<td>0.02</td>
</tr>
</tbody>
</table>

\(^{\text{a}}\) Codex MRLs for fat-soluble pesticide residues in milk & milk products are expressed on a whole product basis

\(^{\text{b}}\) As per CAC, for a "milk product" with a fat content less than 2%, the MRL applied should be half those specified for milk. The MRL for "milk products" with a fat content of 2% or more should be 25 times the maximum residue limit specified for milk, expressed on a fat basis

* On fat basis
** Soluble in water & hence not necessary to mention on fat basis
*** On whole basis in milk
+ For those milk products with fat less than 2%
Notes on Symbols used against MRLs and EMRLs

(*) At or about the limit of determination.
E (only for MRLs) The MRL based on extraneous residues.
F (for milks) The residue is fat soluble and MRLs for milk products are derived as explained in "Codex Maximum Residue Limits/Extraneous Maximum Residue Limits for Milk and Milk Products".
(fat) (for meat) The MRL/EMRL applies to the fat of meat.
Po The MRL accommodates post-harvest treatment of the commodity.
PoP (for processed foods) The MRL accommodates post-harvest treatment of the primary food commodity.
T The MRL/EMRL is temporary, irrespective of the status of the ADI, until required information has been provided and evaluated.
V (for products of animal origin) The MRL accommodates veterinary uses.

Codex Maximum Residue Limits/Extraneous Maximum Residue Limits for Milk and Milk Products

Codex MRLs / EMRLs for fat-soluble pesticide residues in milk and milk products are expressed on a whole product basis.

For a "milk product" with a fat content less than 2%, the MRL applied should be half those specified for milk. The MRL for "milk products" with a fat content of 2% or more should be 25 times the maximum residue limit specified for milk, expressed on a fat basis.

Fat soluble pesticide residues to which the above general provision applies are indicated with the letter "F" in conjunction with the MRL specified for milk. However, in case of an MRL or EMRL set at or about the limit of determination, the letter "F" is not used.
1.0 Introduction

Paneer is an important Indian dairy product. Its origin is not well documented. However, it is reported that probably it was brought into India by invaders from the North-West frontier as well as the nomadic tribes of Afghanistan and Persia in the thirteenth century (Aneja, *et al*., 2000). That is why it has been confined to North-West India. In recent past, the popularity of paneer has transgressed the limit of North-Western India and India as a whole, and is now being popularly consumed in several Western countries also. Its growing popularity has led to its integration into the Indian cuisine. Now, it enjoys the status of a national delicacy.

Paneer is obtained through heat / acid coagulation of the casein component of standardized buffalo milk, entrapping through complex physicochemical interactions almost all the fat, a part of denatured whey proteins and colloidal salts, as well as part of the soluble milk solids (in proportion to the moisture content retained). Good quality paneer is characterized by a white colour, sweetish, mildly acidic and nutty flavour; firm, cohesive and spongy body and closely knit smooth texture. It is sliceable and retains its size and shape on frying and cooking. Paneer is highly nutritious since it retains approximately 90% fat and protein, 50% minerals and 10% of lactose of the original milk. Though the composition of market samples of paneer vary to a large extent, the product prepared by standard method, on an average, consists of approximately 54% moisture, 25% fat, 17.5% protein, 2% lactose and 1.5% minerals.

According to the PFA standard “Paneer means the product obtained from cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70% moisture, and milk fat content shall not be less than 50% of the dry matter. The milk fat content of skim milk paneer shall not exceed 13% of the dry matter”. In order to meet PFA standard, the product has to be made from buffalo milk containing 5.8 to 6.0% fat.

In India paneer production has been largely confined to the non-organized sector of the dairy industry. An estimated 1% of the country’s total milk production is converted into paneer. Its annual production is estimated at 150,000 tonnes. The cost of the paneer production is low because of its significantly higher yield and short preparation time. The yield ranges from 17-18%. More and more dairy plants are going in for paneer production by the batch process (Aneja, *et al*., 2000).
2.0 Technology

2.1 Selection of Milk

It has been reported that the best quality paneer could be made only from buffalo milk containing 5-6% fat (Bhattachrya, et al., 1971). The fat content of milk plays an important role in imparting desirable sensory properties to paneer. It contributes to the soft and spongy body and rich flavour of paneer. Cow milk is reported to result in an inferior product. Milk should be standardized to a fat / SNF ratio of 1:1.65 so that the final product may conform to PFA standard. Paneer of most desirable quality and maximum yield (~22%) could be prepared from buffalo milk wherein fat and SNF is adjusted to 5.8 and 9.5%, respectively (Sachdeva and Singh, 1988). Incorporation of sweet cream butter milk solids to buffalo milk improves the recovery of milk solids and retention of moisture thereby increase the yield of paneer by 1 per cent. Skim milk paneer has an undesirable hard, chewy and rubbery body.

2.2 Heat Treatment

Traditionally milk is boiled and cooled followed by acidification to precipitate the solid contents. However, under laboratory conditions controlled time-temperature combinations have been recommended to obtain good quality paneer with better recovery of total solids. Bhattacharya et al. (1971) reported that a temperature and time combination of 80°C for 10 minutes resulted in better product. Sachdeva and Singh (1988) recommended a heat treatment up to 90°C without holding. The higher heat treatment of milk improves the solid recovery, yield, flavour and body and texture characteristics of paneer. Lower temperatures of final heating resulted in a soft and weak body and a raw milk type flavour which is uncharacteristic of paneer.

2.3 Coagulation

After heat treatment the milk is cooled to 70°C and 1% citric acid solution is added to coagulate the milk. The coagulation pH is between 5.30-5.35. The concentration of 1% solution of citric acid results in the best product. Stronger solutions impart hardness and graininess and cause greater solid loss in whey. About 2.0-2.5 gm of citric acid is required for coagulating 1 Kg of milk. The coagulation of milk at lower temperatures e.g. 60°C results in paneer with a very weak and loose body unsuitable for frying. Also the solid recovery is lower. The higher temperature of coagulation induce greater solids recovery but lower yield due to increased moisture expulsion. The body of such product tends to be hard. The solids recovery increased markedly with the increase in coagulation temperature and was maximum at 90°C.

The adverse effect on the body and texture of paneer obtained on coagulation at 90°C and thereby retaining the maximum total solids can be overcome by incorporation of certain hydrocolloids. The water binding capacity and consistency of paneer is improved by incorporation of 0.1% sodium alginate in milk prior to coagulation. Coagulation at 90°C with the stabilizers incorporated in milk results in higher yield and imparts better body and texture characteristics in paneer, eliminating the cooling step at the same time.
Certain non-conventional, low cost coagulants can be used in manufacture of paneer without any loss of quality or yield. These include inorganic acids, like hydrochloric and phosphoric acids (0.6% soln.), naturally soured whey and cultured whey. Hydrochloric acid is the most economical among the chemical coagulants. The use of naturally soured whey as coagulant cuts down the requirement of citric acid almost 50%, thus reducing the cost of production. In case of naturally soured whey only 0.6% solution of citric acid compared favourably well as against 1% in normal situation without any loss of quality.

Naturally soured whey when used as coagulant results in a good quality paneer but the volume of such whey required to bring about effective coagulation of milk is enormous, posing problems in handling. Therefore, whey cultured with L. acidophilus at the rate of 2% and incubated at 37°C for 72 hrs is used which completely eliminates the need of citric acid for coagulation. The use of cultured whey increases the solid recovery without any adverse effect on the sensory attributes of paneer.

A 1% solution of citric acid heated to 70°C is added slowly to the milk with continuous agitation till clear greenish yellow whey separates out. The stirring is stopped and the curd is allowed to settle down at the bottom of the vat.

2.4 Draining, Hooping and Pressing

After about 5 minutes of settling down, the whey is allowed to drain through a strainer. Precaution should be taken to ensure that the temperature of the curd does not go below 63°C during draining. The curd is transferred to hoops lined with cheese cloth. The hoops are perforated on all sides to facilitate whey drainage. Appropriate level of pressure (2-3 kg/ sq cm) is applied for 10-15 minutes followed by removal of the paneer from the press. The paneer block is transferred to the potable tap water to cool it down.

2.4 Cooling and Chilling

When the temperature of paneer reaches close to that of cooling water, it is transferred to chilled water at about 4°C. After the temperature of paneer reaches 5-10°C, it is removed from the water and allowed to drain till all loose water is removed. The paneer is then cut into the pieces of desired sizes and packed in suitable packaging materials. The packed paneer is transferred to the cold storage till disposal. Deep chilling to low temperature is essential to prolong its shelf life.

2.5 Packaging

Packaging helps to protect the product, maintain its quality, provide consumer convenience and merchandizing. Normally paneer blocks of required size / weight (100, 250, 500, 1000 gm) are packaged in polyethylene pouches, heat sealed and stored under refrigerated conditions 98-10°C). Other packaging materials used are wax- coated parchment paper, cryovac films, coextruded laminates and retort pouches. Now the vacuum packaging of paneer in laminated or coextruded films has been introduced to prolong its shelf life.
2.6 Yield

It depends on the fat and SNF content of milk as well as on retention of moisture, fat and proteins in paneer. Under optimum condition of manufacture, an yield of 20-22% of paneer for buffalo milk and 16-18% for cow milk is obtained. This yield corresponds to 65-67% milk solids recovery.

2.7 Spoilage

It has been observed that the spoilage in paneer starts from the surface with the formation of the greenish-yellow slime. A putrid odour with an acidic and bitter taste develops in paneer on storage, rendering it unacceptable. The major changes occurring during storage of paneer are glycolysis and proteolysis.

It has been reported that the total plate count of fresh paneer made in pilot plant ranges in the order of $10^1$ to $10^3$ / g which increases consistently during storage reaching final values of the order of $10^4$ to $10^6$/g. Generally, the total bacterial count adversely affects the flavour quality of paneer. The initial yeast and mould count of paneer is in the ranges of $10^1$ which increases during storage reaching final values in the range of $10^3$ /g. The paneer is almost free of coliforms (Sachdeva and Singh, 1991).

With respect to chemical changes the initial pH of paneer is in the range of 5.5 to 6.0 which increased during storage up to 7 days followed by either a decrease or leveling off. The initial titratable acidity of paneer is in the range of 0.2% which increases reaching the level of about 0.3% at the end of storage. The soluble nitrogen content of fresh paneer is about 0.10% which increases to the level of approximately 0.20% in about one week of storage. The level of soluble protein content was positively correlated to the deterioration of paneer.

The market samples showed wide variation both in chemical and microbial quality of paneer. Rajorhia, et al. (1984) reported that the moisture content ranged from 39-67% (average 51%), fat 12-37% (av. 27%), protein 12-21% (av.18%) and lactose 1-3% (av.2%). With respect to microbial quality the standard plate count ranged from $6\times10^5$ – $20^9$ (av. $52\times10^7$), coliform count $1\times10^2$-$25\times10^6$ (av. $98\times10^5$) and yeast & mould count $10\times10^1$-$92\times10^3$ (av. $119\times10^2$) /g.

3.0 Preservation

The paneer is highly perishable product. The marketing of paneer is limited to local sales because of its limited shelf life. The high moisture content (~55%) in paneer makes it highly vulnerable to spoilage and it does not keep good for more than one day at ambient temperature and one week at refrigeration temperature. If it is prepared under hygienic and sanitary conditions it can be kept well for about a week at refrigeration temperature. It has been reported that if paneer is dipped in 5% sodium chloride brine solution prior to packaging, it enhances the shelf life up to 22 days at refrigeration temperature. Almost the same result was obtained by dipping paneer in 0.2% hydrogen peroxide solution. When paneer was dipped in a fungicide solution (delvocid, 0.5%) following hydrogen peroxide treatment, its shelf life increased up to 32 days in cold storage (Sachdeva and Singh, 1990).
Delvocid, the commercially available Pimericin / Natamycin may be a potential preservative to control the mould growth in paneer as the intake level of 0.3 mg / kg body weight recommended by the Joint FAO / WHO Expert Committee of food additives, is not attained even by consumption of extreme quantities of Delvocid treated paneer (Sachdeva and Singh, 1985). Addition of sorbic acid to milk (0.15%) and wrapping paneer in waxed paper, coated with sorbic acid, may extend its shelf life up to 5 weeks at ambient temperature. The sorbic acid content of paneer should range from 0.15-0.30 per cent (Aneja, et al., 2002).

Dehydration and deep-freezing extend the shelf life of paneer. However, textural problems may be observed in partially dehydrated paneer. It has to be protected from drying out during storage. Paneer packaged in moisture–barrier film pouches provides the best shelf life of several months in cold storage.

Sachdeva et al. (1991) reported that vacuum packaged paneer blocks of 10x4x6 cm size in cryovac polyethylene kept well up to 30 days at 6 °C. The body and texture of paneer improved on vacuum packaging as it became more compact and sliceable. Punjrath, et al. (1997) reported that vacuum packaging of paneer in specific film (EVA / EVA / PVDC / EVA) followed by heat treatment at 90°C for 1 minute could help extending the shelf life up to 90 days at refrigeration temperature.

Freezing improves the shelf life of paneer considerably. On storage of paneer at sub-zero temperatures at –13 and –32°C for 120 days, the flavour and appearance is not affected adversely but its body and texture deteriorates and the product becomes crumbly and fluffy on thawing (Arora and Gupta, 1980). Blast freezing has recently been used to enhance the shelf life of paneer. The paneer block is cut into pieces of approximately 1.5 x 1.5 x 1.5 cm size and blast frozen at a temperature below –20°C. The product can be stored under frozen conditions (below –18°C) for more than 1 year without any deterioration in its quality (Punjrath et al., 1997).

Makhal (2000) investigated the efficacy of four “GRAS” additives, viz. cardamom, clove, cinnamon and ginger in preservation of paneer. The additives were individually added to milk at the time of coagulation. Ginger, cardamom, clove and cinnamon were quite effective in enhancing the shelf life of paneer at their medium level of dose (8 g ginger and 1.5 g cardamom, clove and cinnamon / kg milk up to 36,32,28 and 28 days respectively at 5°C. Overall, the treatment of paneer with medium does of ginger was most effective followed by medium dose of cardamomaand clove / cinnamon, respectively.

Heat sterilization of paneer is reported to be the only effective method to improve the shelf life of paneer at ambient temperature. Paneer cubes packed in tins and sterilized in autoclave at 15 psi for 15 minutes kept well over a period of 50 days at room temperature. The perception of a mouldly character rendered the paneer unacceptable thereafter. A slight amount of browning accompanied with cooked flavour affected the organoleptic quality of paneer, but this adversity was overcome to a great extent when sterilized paneer was fried and cooked. Sterilization along with small amount of water in the tin helped in reducing the degree of defects produced by heat.
3.1 Hurdle Technology

A formulation of gravy and paneer packed in retort pouches and subjected to heat treatment is an attractive convenience food. A systematic study has been carried out to develop such a product based on the concept of hurdle technology (Rao, 1993). According to this concept, preservation parameters like water activity, pH, redox potential, heat treatment etc are hurdles. Most of the food can not be preserved by a single hurdle alone without affecting their sensory and nutritional properties. Paneer, for instance, can not be preserved by lone hurdle of heat treatment or dehydration or pH because its body and texture and nutritive value get affected. By using three or more hurdle together, not only the damage to sensory properties is kept minimum but also their synergistic action is exploited (Jayaprakasha et al, 1997). The paneer curry developed by hurdle technology had a shelf life of about a month at 30°C and more than 3 months at 15 °C. The water activity of gravy and paneer was reduced to 0.95 by using suitable humectants. The pH was lowered to 5.0 by a proper admixing of dahi and skim milk powder. The gravy was prepared by using onions, tomatoes, usual spices and condiments, humectants and potassium sorbate. The overall composition of the product was: total solids 40.27%, fat 24.99%, protein 58.8% and ash 3.16%, carbohydrates and glycerol constitute 6.24%.

4.0 Types of Paneer

4.1 Cow Milk Paneer

Cow milk is not considered suitable for making good quality paneer. Cow milk paneer is relatively weak, soft, loose and pasty and tends to break down during cooking. Addition of calcium chloride to the cow milk at the rate of about 0.1% and coagulation at higher temperature of 85°C instead of 70°C improves the quality of resulting paneer. The paneer shows more compact, sliceable, firm, cohesive and spongy body and close-knit texture. Overall the sensory characteristics improve significantly (Singh and Kanawjia, 1988).

4.2 Low Fat Paneer

The conventional paneer is quite rich in fat content, which not only increases the price but also makes it unsuitable to those who are conscious of high fat and want to have relatively low fat paneer. Moreover, generally paneer is used as an ingredient for certain culinary preparations involving frying and cooking, the high fat content may not be an absolute requirement. Therefore, attempts were made to develop a low fat paneer with acceptable sensory quality. It has been observed that quite good quality paneer could be made from milk with fat content as low as 3.0-3.5%. The relatively low temperature of coagulation (65°C) helped in improving the quality of paneer. Fortification of low fat milk with calcium soy isolate / calcium groundnut isolate not only improves its rheological and sensory characteristics but also reduces its cost of production.

4.3 Recombined and Reconstituted Milk Paneer

Due to seasonal nature of milk production, there is a drastic cut in milk supply during summer whereas the requirement of paneer goes up during these days because of marriage season. Consequently, prices shoot-up and the consumers are at a great loss. Therefore,
technology has been developed for manufacture of acceptable quality paneer from recombined and reconstituted milk.

The recombined milk is prepared by blending cow skim milk powder, butter oil and potable water at about 50°C. The content is homogenized at 2000 psi and given 3-4 hr reaction time after which paneer is made by the procedure standardized by Chawla, et al. (1985) with slight modifications. Calcium chloride is added to the recombined milk at the rate of 0.15% during heating of the milk. The coagulation is affected at 90°C. The further procedure followed is as for the normal paneer.

Reconstituted milk paneer was made from whole milk powder. Buffalo milk powder was dissolved in potable water at 50°C to give reconstituted milk of 15% TS. The milk was allowed 3-4 hr to complete the reaction followed by conversion into paneer by the method recommended by Chawla, et al. (1985) with slight modification. The best quality paneer was obtained by coagulating the milk at 85°C.

4.4 Filled Milk Paneer

During flush season there is so much milk that sometimes dairy plants declare milk holidays. This results in slumps in sale price of milk. Milk fat is utilized for the manufacture of butter and ghee but the skim milk does not find proper use, particularly at the mini-dairy plant level, which does not have drying facilities. Under such situations skim milk can be better utilized for manufacture of filled milk paneer, a value added product. Roy and Singh (1999) reported that paneer of quite acceptable quality can be prepared by using buffalo skim milk and groundnut oil / vanaspati. For proper mixing of skim milk and vegetable oils use of blendor / household mixi at 40°C for 5 minutes at low speed is quite suitable. A fat level of 5.5% in the filled milk and its heating to 90°C without holding were found to be suitable conditions. The coagulation is done at 70°C. If coagulation is done at 90°C the resulting paneer becomes hard and dry. To overcome this problem 0.10% pregelatinized starch can be added to the filled milk prior to coagulation. The paneer thus made contains 55-56% moisture, 22-23% fat and 16-18% protein. The process developed is relatively simple and permits the use of commonly available equipment for manufacture of paneer on both small and industrial scale. The cost of production is considerably reduced. Venkateswarlu et al. (2003) standardized the process for manufacturing paneer from skim milk incorporated with coconut milk of 25% fat. Sensory quality of the product made from filled milk having 10% coconut milk was highly acceptable.

4.6 Protein Enriched Filled Milk Paneer

A process has been developed for preparing protein enriched filled milk paneer (Roy and Singh, 1990). The process involves supplementation of vegetable proteins in the form of calcium isolates or calcium groundnut isolates to the skim milk and vegetable fat mixture. The author claimed that such product would be nutritionally (protein increased by 50%) and economically superior to the conventional paneer and thus ideally suits to dietary management of consumers suffering from protein malnutrition and coronary complications.
4.7 Soy Paneer

Soy paneer can be made using soymilk made from whole soybean. One kg of soybean yields about 8 litres of soy milk containing 5.7-5.9% TS, 1.5-1.6% fat and 3.1-3.2% protein. The soymilk is boiled and cooled to 70°C for coagulation. The calcium sulphate / magnesium sulphate used as coagulant yields a desirable product whereas citric acid results in a product with acidic taste and brittle body. The soy paneer is generally criticized for being beany and lacking in fibrous texture. Addition of milk fat to soy milk does not improve the flavour, however, calcium caseinate supplementation (1-2%) has beneficial effect in reducing the intensity of beany flavour and improving the body and texture characteristics of soy paneer. The average yield of soy paneer is about 25% which is increased to about 28% by addition of 2% calcium caseinate in soymilk.

4.8 Groundnut Paneer

Groundnut milk is prepared from deskinne groundnut roasted at 120°C for 5-10 minutes by grinding with water in a mixer / micropulverizer followed by filtering, adjustment of pH to 6.8 with the addition of lime water prior to boiling. The content is brought to boil and the live steam is bubbled through the milk for 30-60 minutes to remove nutty flavour. If needed extra water is added so as to obtain 8 litres of milk for every kg of kernel processed. The groundnut milk contains 9.8-10.2% TS, 4.7-5.1% fat 3.6-3.8% protein.

The boiled groundnut milk is cooled to 70°C and coagulated with calcium sulphate, magnesium sulphate or citric acid followed by draining, hoping and pressing for 5 hours for salt coagulants and 1 hour for citric acid. The paneer is finally dipped in chilled water for about 1 hour. The paneer is generally criticized for nutty flavour, weak, fragile, brittle and soft body. It lacks fibrous texture. During frying disintegration and erosion of surface particles from the cubes take place. Overall the paneer is not acceptable. Addition of 50% skim milk to the groundnut milk markedly improves the quality of paneer. The paneer thus obtained contains 42.5% TS, 15% fat, 23% protein, 2.7% carbohydrates and 1.6% minerals. Its rheological characteristics are quite comparable to those of normal milk paneer. The yield of paneer prepared from groundnut milk blended with equal amount of skim milk is about 17 % (Roy and Singh, 1990).

4.9 UF-Paneer

The membrane processing has a potential application in the manufacture of paneer. Ultrafiltration (UF) when employed for paneer manufacture offers advantages like access to mechanization, uniform quality, improved shelf life, increased yield and nutritionally better product. The process developed (Sachdeva et al., 1993) involves standardization and heating of milk followed by UF whereby lactose, water and some minerals are removed. Ultrafiltration of milk and the removal of permeate is synonymous to removal of whey by coagulation in conventional method. The concentrated mass, which has about 40% TS, is cold acidified to get the desired pH. Till this point, the product is flowable and can be easily dispensed into containers with automatic dispensing machines. The filled containers are then subjected to texturization by microwave heating in domestic microwave oven. This can also be achieved in a continuous process by using microwave tunnels. Such tunnels comprise of a
series of magnetrons under which the product moves continuously on the conveyor belts. The resulting product has typical characteristics of normal paneer.

In another approach, an in-package process has been developed which yields a long shelf life paneer-like product (Rao, 1991). The in-package sterilization UF process is based on the principle of first standardizing / concentrating the milk to the desired composition, followed by concomitant ‘texturization / heat sterilization’ in hermetically sealed retortable pouches. The process permits retention of greater amount of whey solids in paneer and consequently gives higher yields. The process involves standardization of pasteurized milk to a fat content of 1.5% and SNF to 9.0% followed by ultrafiltration to a total solids content of 30%. To this glucano-δ lactone is added @ 0.9% prior to filling in retortable metalized polyester pouches of 200-500ml. These sachets are then sterilized in an autoclave at 113°C for 14 minutes, during which concomitant thermal texturization also takes place resulting in formation of along shelf life product.
1.0 Introduction

Fermented milk and milk products have occupied a place of complacency in satisfying the palate and nutritional requirements of human being since the time antiquity. The fermentation is used as a method of value addition and conversion of raw materials by microorganisms and enzymes into various types of products with distinct nutritional and sensory properties. Fermented milk products have been reported to have therapeutic, anticholesterolemic, anticarcinogenic and anticirogenic properties beyond their basic nutritive value. They, contributing to a variety in our gustative desire, have been recognized to provide important nutrients and considered superior over non-fermented dairy products in terms of nutritional attributes as the micro flora present produce simple compounds like lactic acid, amino acids and free fatty acids that are easily assimilable.

2.0 Dahi

Dahi, Indian curd, is a well known fermented milk product consumed by large sections of the population through out the country, either as a part of the daily diet or as a refreshing beverage. In India, dahi also known ad dadhi is largely made at home using traditional kitchen recipes, involving milk of buffaloes, cows and goats. Generally a mixture of cow and buffalo milk is used. Milk is boiled and cooled, inoculated with dahi starter, usually the left over from the previous day’s stock, and incubated undisturbed at ambient temperature for four to six hours until it acquires a thick consistency. Dahi is generally consumed in its original form as an accompaniment to the meal or it may be converted into raita. Dahi may be consumed as such or as sweet or savoury drink as a dessert containing sugar, spices, fruits, nuts, etc. An extensive all-India survey project on dahi revealed that there are, broadly speaking, two types of dahi prevalent in the country for direct consumption, viz. a sweet/mildly acidic variety with a pleasant flavour, and a sour variety with a sharp, acidic flavour.

The PFA Act defines dahi or curd as a semi-solid product, obtained from pasteurized or boiled milk by souring (natural or otherwise), using a harmless lactic acid or other bacterial cultures. Dahi may contain additional cane sugar. It should have the same minimum percentage of fat and solids-not-fat (SNF) as the milk from which it is prepared. Where dahi or curd, other than skimmed milk dahi, is sold or offered for sale without any indication of the class of milk, the standards prescribed for dahi prepared from buffalo milk shall apply.
The Bureau of Indian Standards (BIS) specifications for fermented milk products are based on the type of culture used in their preparation. Mild dahi is made from mesophilic lactococci. Leuconostocs may be adjunct organisms for added buttery odour and flavour. Sour dahi contains additional cultures belonging to the thermophillic group, which are generally employed in the manufacture of yoghurt. These thermophillic organisms grow rapidly at 37-45°C, producing dahi in less than 4 hours.

Like dahi, yoghurt is a semi-solid fermented product made from a standardized milk mix by the activity of a symbiotic blend of *Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp. bulgaricus* cultures. For brevity we shall term the yoghurt culture organisms as ST and LB and typical dahi organisms as LL. The body and texture of yoghurt depends largely on the composition of milk employed in its manufacture. Although milk of various mammals can be used for making cultured dairy products, their industrialized production is mainly based on milk of cows and buffaloes.

### 2.1 Classification

In general, dahi may be classified into two types:

1. For direct consumption.
2. For churning into desi butter (makkhan)

In a country as big as India, the consumers have different taste preferences for traditional products varying from region to region. This made the traditional products available with a varied taste. Dahi is also made in different varieties with region specific tastes. The technological developments have led to the commercialization of this product. Dahi may be classified on the following basis.

#### According to use

- a) Dahi for direct consumption
- b) Dahi for the production of chakka, shrikhand, lassi and butter milk.
- c) Dahi for the production of desi butter and ghee.

#### According to consumption

- a) Whole milk dahi
- b) Skim milk dahi
- c) Toned milk dahi
- d) Standard milk dahi
- e) Dahi from special milk

#### According to flavour

- a) Sweet dahi (acidity not more than 0.7%).
- b) Sour dahi (acidity not less than 0.7%)
- c) Sweetened dahi
- d) Fruit dahi
2.2 Composition

Dahi made from buffalo milk produces a thick bodied product because of its high SNF content. It is recommended to make dahi/ yoghurt from a mix containing 11-13 percent SNF. The increased protein content in the mix results in a custard like thick consistency following the required fermentation. Higher milk solids also keep the product from wheying off. Dahi prepared from whole milk contains about fat 5-8, protein 3.2 – 3.4 lactose 4.6 – 5.2, Ash 0.70 – 0.72, and titratable acidity 0.60 –0.80 percent.

2.3 Method of Manufacture

2.3.1 Traditional method

In this method dahi is prepared at small scale, either in the consumer’s household or in the confectionary (Halwais) shop. In the household, the milk is boiled, cooled to room temperature, inoculated with 0.5 to 1.0 percent starter (previous day’s dahi or butter milk) and then incubated undisturbed for setting for about overnight. In cold weather, the dahi setting vessel is usually wrapped up with woolen cloth to maintain appropriate temperature. In the confectionary shops, the method employed for preparation of dahi is more or less same except that the milk is concentrated in an open pan before inoculation and usually dahi is set in an earthenware.

2.3.2 Standardized method

As stand process on the basis of scientific lines has been developed for dahi making in the organized sector. Fresh, sweet, good quality milk is received, pre-heated and subjected to filtration and clarification. The milk is standardized to 2.5 to 3.0 percent fat and 10 percent solids not fat, pre-heated to 60°C and homogenized single-stage at a pressure of 176-kg/sq cm. The milk is heated to 85 – 90°C for 15-30 minutes, cooled to 22-25°C and inoculated with 1-2 percent of specific dahi starter culture. It is then filled in suitable packaging containers of the appropriate size and incubated at 22-25°C for 16-18 hours. After proper setting of the dahi, the acidity of dahi reaches 0.6 to 0.7 percent and a firm curd is formed. The curd is cooled by circulating chilled water or air around the containers and then transferred to cold room maintained at about 4-5°C. The flow diagram for manufacture of dahi is presented here under (Fig. 1).

3.0 Mishti Dahi

Mishti dahi or mishti doi is a popular traditional sweetened fermented milk product. The eastern parts of India, especially in West Bengal, Assam, Bihar and Orissa, the sweetened variety of dahi known as Mishti dahi, Lal dahi or Payodhi is quite popular. The product is prepared by the Halwais on a small scale. It is a delicacy of choice during religious festivities and is considered an auspicious item to serve while starting journey or any important work. The product is commonly sold in earthen pots of varying sizes, and served chilled.
Fig. 1. Manufacture of Dahi

3.1 Composition of Mishti Dahi

Mishti dahi is a fermented milk product, having creamish to light brown colour, firm body, smooth texture, sweet-acidic flavour, and pleasant aroma. As such, there is no prevention of food adulteration (PFA) Act or BIS standards for mishti dahi. In the absence of legal standards, mishti dahi differs in terms of chemical composition as well as sensory attributes. The quality of mishti dahi depends upon the type of milk, level of concentration, and fermentation conditions employed in its manufacture. The typical composition of mishti dahi is given in table 1.

3.2 Method of Manufacture of Mishti Dahi

3.2.1 Traditional method

Traditionally, mishti dahi is prepared from cow or mixed milk. The fresh good quality milk is boiled with a required amount of sugar and partially concentrated by simmering over a low fire. This heating is continued for quite some time during which milk develops a distinctive light cream to light brown caramel colour and flavour. The content is then cooled to ambient temperature and cultured with dahi (lactic) culture. It is then filled into earthen
pots of consumer size or bulk size vessels and incubated over night. Normally the curd is set within 12-14 hours. After firm setting of curd, it is transferred to a cooler place or stored under refrigeration.

<table>
<thead>
<tr>
<th>Constituent (%)</th>
<th>Low fat</th>
<th>Medium fat</th>
<th>High fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk fat</td>
<td>2-3</td>
<td>4-5</td>
<td>8-9</td>
</tr>
<tr>
<td>Milk SNF</td>
<td>13-14</td>
<td>11-13</td>
<td>10-11</td>
</tr>
<tr>
<td>Sugar</td>
<td>17-19</td>
<td>17-18</td>
<td>17-18</td>
</tr>
<tr>
<td>Total solids</td>
<td>32-35</td>
<td>32-36</td>
<td>35-38</td>
</tr>
</tbody>
</table>

### 3.2.2 Industrial production

In the organized sector, mishti dahi is manufactured employing developed technological process. A wide range of milk products for sourcing milk solids is used in the production of mishti dahi. For this purpose, milk solids are used from fresh cow/buffalo milk, cream, skim milk powder (SMP), whole milk powder (WMP), evaporated whole milk, sweetened condensed milk and white butter.

The required ingredients is blended in proper proportion, keeping in view the final compositional standard of the product in terms of fat, SNF, and sugar. There is a need to select fresh and good quality ingredients in relation to microbial and sensory quality. The raw material milk used for mishti dahi preparation should be fresh, free from off-flavours and clot-on-boiling negative.

The most common sweetening agent used in preparation of mishti dahi is cane sugar. Other sweeteners such as corn sugar, corn syrup, and also sugar or maltose can be used as sweetening agent. Some times in preparation of some special varieties of mishti dahi, fresh palm jaggery is used as a sweetener. Commercially cane sugar of high microbiological quality and free from extraneous matter is used as sweetening agent.

Mishti dahi is colored and flavored commonly with caramel. Caramel is prepared from heating sugar and it is available commercially in a viscous form (76% TS). Caramel is soluble in water and having a specific gravity of 1.315 to 1.345. Synthetic flavours like caramel, vanilla, cardamom, rose, pineapple, etc may also be used. Fruits and dry fruit, nuts may also be used for developing a wide variety of mishti dahi.

The most critical and important step in the manufacture of the mishti dahi is the selection of appropriate type of starter culture since it affects the flavour, consistency and acidity development in the presence of sugar and caramel at relatively higher TS levels. As such starter culture is regarded as heart of mishti dahi preparation. Mixed strain culture may be used since it yields a superior product and most reliable under variable processing conditions. The optimum activity of the mishti dahi culture is expected in a narrow temperature range of 40-42°C. Normally a good starter culture with 1.0 percent inoculum develops 0.70 percent acidity within 6-8 hours.
3.2.3 Process

The required quantities of milk, cream, skim milk powder and sugar are blended. Caramel is added normally at the rate of 0.10 to 0.12 per cent. The mix is heated to 80° – 90°C in a vat or a plate heat exchanger. Various time-temperature combinations have been tried but heating the mix to 85°C for 15 minutes resulted in a highly desirable flavour and textural qualities. After heat treatment, the mix is cooled to 40-42°C either employing heat exchanger or by circulating chilled water in the jacket of vat. The starter culture is added to the mix at the rate of 1.0 percent and thoroughly mixed using stirrer. Thereafter, the mix is filled in sanitized cups of required sizes and covered with lids. The cups are properly heat sealed to make them airtight and prevent leakage. These cups are then incubated at 40-42°C for about 6-8 hours till the acidity develops to about 0.70 to 0.80 percent LA. At this acidity the mix will well set and a desired consistency and firmness is attained. After proper setting, these cups are transferred to a cold store of 4-5°C temperature. For long storage, normally the temperature of cold store is maintained at 0°C.

3.3 Production of Mishti Dahi from Buffalo Milk

Fresh buffalo milk is standardized to 3.5% fat and 9.0% SNF, heated to 65°C in a plate heat exchanger and homogenized at a pressure of 56 kg/cm² (one stage). Milk is concentrated at 1.44 fold in a vacuum evaporator. After adding cane sugar, the milk is heated at 85°C for 5 min to generate cooked flavour. The mix is water cooled to 40°C before inoculation with the mixed culture (LF-40). In some cases, sugar caramel, jaggery and artificial colors are added to impart brown colour. The inoculated mix is aseptically distributed into pre-sterilized polystyrene containers (200 ml) and mechanically transferred to incubation chamber at 40°C. After 7 h of incubation, the product is shifted to cold store maintained at 4°C. During gel formation, milk must remain stationary. In the flow chart (Fig.2), fermentation is designed as a batch process. In all post fermentation activities, gel should be subjected to a minimum amount of external influences.

4.0 Probiotic Dahi

Probiotic foods are the most important discipline of functional foods, which are defined as foods containing live microorganisms, which actively enhance the health of consumers by improving the balance of microflora in the gut when ingested, live in sufficient numbers. Several studies have related the promising health benefits of consuming cultured and culture containing milks. There have been long term interests of using cultured milk products with various strains of LAB and other probiotic bacteria to improve the health of humans. The consumption of probiotic products is helpful in maintaining good health, restoring body vigour, and skirmishing intestinal and other diseases. Fuller (1989) listed out the claimed beneficial effects and therapeutic application of probiotic bacteria in humans, which includes: (i) beneficial effects, such as maintenance of normal intestinal realm, augmentation of immune system, reduction of lactose intolerance, reduction of in serum cholesterol levels, anticarcinogenic activity, and improved nutritional value of foods, and (ii) therapeutic applications, such as prevention of urogenital infections, mitigation of constipation, protection against travellers’ diarrhea, prevention of infantile diarrhea, reduction of antibiotic induced diarrhea, prevention of hypercholesterolemia, protection
against colon/bladder cancer and prevention of osteoporosis, etc. Probiotic bacteria, thus, offer new dietary alternatives for the management of such conditions through stabilization of intestinal microflora, promotion of colonization resistance, regulation of the immune response and preservation of intestinal integrity.

Fig. 2. Flow diagram for manufacture of Mishti Dahi

Recently, at NDRI probiotic dahi has been developed with enhanced health attributes. The probiotic lactobacilli viz. *L. acidophilus* and *L. casei* used to prepare dahi either alone or in combination with mesophilic dahi culture *Lactococcus lactis* ssp. *lactis* biovar. *diacetylactis*-60 and mixed dahi culture 167 (BO4). Standardized buffalo milk (fat 4%) as well as milk with different fat % (1 to 3%) is used for preparation of two types of Dahi. Dahi incubation carried out at 37°C for 9-10 hours. After incubation dahi is stored at 4°C (approx.). Dahi exhibited good taste and flavour, also good; texture is firm exhibiting pH 4.27 to 4.47 and titratable acidity ranging from 1.08-.1.21. A number of probiotic organisms are 7.1x10^10 approx. Number of probiotic organisms is ranged from 3.8 x10^{10} - 4.24x10^{10}.

5.0 **Fruit Dahi**

India is also amongst largest fruit producing countries, with vast horticulture base consisting wide range of fruit varieties. The production of fruits in India is confined to 27.8 MT, which amounts to 8.1% of the total world fruit production. Post harvesting losses in India are also amongst highest in the world at 30-35 % resulting in a great loss to our
The major hurdle in the successes of fruit process industry is the lower demand of processed fruits. The poor purchasing power of Indian consumers and current fruit market structure does not offer a competitive environment to fruit processing industry. Also there is a need to create new avenues for fruit products as our fruit production is increasing rapidly. All these factors demand creation of new avenues for the utilization of fruit products. Keeping in view, the market trend in western dairy market, incorporation of fruits in to fermented milk product would generate a great demand for processed fruits, which might help checking the post harvest losses and the economic loss to the nation and would enhance the profitability of milk and fruit producer as well as processors.

5.1 Manufacture of Fruit Dahi

The processing parameters for manufacture of fruit dahi have been standardized for the development of good quality fruit dahi using various fruits, such as mango, pineapple and banana (Fig.3). Appropriate starter cultures have been employed to get desired flavour and consistency in the product. The rheological properties of the fruit dahi have been enhanced by incorporation of exopolysaccharide producing cultures and hydrocolloids. The shelf life of the product is about 3 weeks at refrigeration temperature. This newly developed fruit dahi with firm body, smooth texture and with delicate balance of fresh fruity aroma and a typical dahi flavour will have greater aesthetic appeal and will cater to the growing needs of Indian dairy industry. The millions of milk producers and fruit growers will be benefited with this technological development. The technology has tremendous techno-economic feasibility.

![Schematic Diagram for Fruit Dahi Manufacture](image-url)
6.0 Conclusion

Fermented milks have been produced and consumed since ancient times. Dahi has managed its popularity in Indian diet despite changing life styles and food habits with time. It is preferred over milk due to good taste high nutritive and therapeutic value and most importantly, enhanced keeping quality than milk in a tropical climate like ours. It is being consumed as plain, sweetened or salted and spiced. At present several types of fermented milk products such as dahi, mishti dahi, fruit dahi, probiotic dahi, lassi, yoghurt, shrikhand, etc. are being produced and marketed. Many people recognized the dietetic and prophylactic properties of fermented products and their healing effects in certain conditions. As a result, the use of various types of fermented milks has found a wide application.

7.0 Suggested Readings


1.0 Introduction

*Lassi*, is a traditional beverage having its origin in India and is popular in South Asia in different varieties. The product, as is known conventionally in India denotes the buttermilk obtained after churning the butterfat from cream or *dahi*. The product is relished sweet in the northern parts of the country, whereas the sour variety is preferred in the south. *Lassi* finds mention in ancient Indian scriptures along with its precursor *dahi*.

2.0 Traditional Varieties of *Lassi*

*Lassi* is a traditional South Asian beverage, originally from Punjab (India, Pakistan) made by blending *dahi* with water, salt and spices until frothy. It is a healthy dairy beverage, the thickness of which depends on the ratio of *dahi* to water. Thick *lassi* is made with four parts *dahi* to one part water and/or crushed ice. It can be flavored in various ways with salt, mint, cumin, sugar, fruit or fruit juice and even spicy additions such as ground chilies, fresh ginger or garlic. The ingredients are all placed in a blender and processed until the mixture is light and frothy. The *lassi* of Punjab sometimes uses a little milk (to reduce the acid tinge) and is topped with a thin layer of *malai* or clotted cream. The beverage is enjoyed chilled as refreshing beverage during extreme summers. Saffron *lassi*, which are particularly rich, are a specialty of Jodhpur (Rajasthan).

In the southern part of the country, *lassi* is preferred as a salty beverage. It is referred to as ‘buttermilk’, as it is the by-product obtained after churning *dahi* for buttermaking. This buttermilk is either consumed fresh after salting, or is used as an accompaniment with rice. Several culinary dishes are also prepared from this by-product. While *kadhi* is popular in the northern and western parts of the country, *kaalan* varieties are popular in the south.

*Lassi* has also become quite popular on hot summer days in Turkey, where it typically contains only water, salt, yoghurt and lemon. In areas of the Middle East including Iran and Lebanon, a similar salty yogurt beverage, named *doogh*, is popular. Sweet *lassi* is a more recent invention, flavored with sugar, rosewater and/or lemon, mango, strawberry or other fruit juice. During 2002, commercial products resembling sweet *lassi* began appearing on the U.S. market, with names like Drinking Yoghurt and Yoghurt Smoothie.
3.0 Health Benefits Attributed to Lassi

The health-giving and vitalising properties of fermented dairy products such as dahi, yoghurt, kefir and koumiss have been documented since ancient times. In general, fermentation plays a few specific roles in foods:

- Bio-enrichment of food substrates with protein, essential amino acids, essential fatty acids and vitamins
- Detoxification during food fermentation processing
- Enrichment of the human diet through development of a wide diversity of flavours, aromas and textures of food
- Immune modulation
- Preservation of foods via lactic acid, alcoholic and acetic acid fermentations
- Reduction in cholesterol
- Reduction in liberation of carcinogenic end products
- Restoration of ecological balance of intestinal flora and
- Suppression of pathogens.

The nutritive value of fermented milk products is derived from the nutrients among various metabolites produced by lactic acid bacteria (LAB) during fermentation besides the nutrients available from milk. Some of the reported nutritional and physiological benefits of fermented milks are the promotion of growth and digestion, settling effect on the gastrointestinal tract (GIT) by decreasing harmful bacteria, improving bowel movement, ameliorating immunity and mineral absorption, suppression of cancer and lowering of blood cholesterol. The LAB have also been used to manage intestinal disorders such as lactose intolerance, acute gastro-enteritis due to rotavirus and other enteric pathogens, adverse effects of pelvic radiotherapy, constipation, inflammatory bowel disease and food allergy. These diseases are associated with disturbances in the intestinal microflora and various degrees of inflammation of the intestinal mucosa leading to increased gut permeability. Therefore, LAB employed in the treatment of these conditions should be able to survive gastric acidity, adhere to the intestinal epithelial cells and colonise the intestine at least temporarily.

Milk, according to Ayurveda, is a laxative whereas dahi has the opposite effect of curing diarrhoea. This has been amply authenticated in current experiments involving fermented milks and probiotic organisms. Studies conducted at the Danone Research Centre (2001) illustrate that feeding dahi and UHT-dahi to children suffering from diarrhoea cured them of the disease within a period of 2 to 2.7 days. Buttermilk warmed with curry and/or coriander leaves, turmeric, ginger and salt is relished in Kerala. This culinary practice, as per the ancient science of ayurveda, is the reason for least cases of obesity and indigestion reported in the state. Regular use of buttermilk is also said to cure haemorrhoids (piles), swelling and duodenal disorders. With a little turmeric powder mixed in, it is also used as a treatment of gastroenteritis.
4.0 Research Developments in Lassi

*Lassi*, in its scientific definition is described as a fermented milk beverage obtained after the growth of selected culture, usually lactic streptococci, in heat treated or partially whole milk followed by sweetening with sugar. It is consumed as a cold, refreshing, therapeutic beverage usually in summer. It is prepared by breaking the curd into fine particles by agitation, addition of sugar, water and optionally flavour. Byproduct obtained in the preparation *desi* butter from *dahi* by indigenous method is also known as *lassi*, composition of the product varying considerably with composition of *dahi* and method of manufacturing.

*Lassi*-like cultured milks containing whey and buttermilk were developed to explore the potential demand of *lassi* and also to utilize these dairy byproducts in a profitable manner. Several workers have reported different raw materials, additives and treatments used for the purpose. *Lassi* using buttermilk and soybean was made by Deka *et al.* (1984). The blanched soybean cotyledons were ground with buttermilk to get a slurry with a soy-solids-buttermilk solids ratio 2:1. The slurry (12% TS) was homogenized (175 and 35 kg/cm$^2$ at 65°C), pasteurized (85°C) and inoculated with *L. bulgaricus* + *S. thermophilus* @ 2 percent. After incubation at 37°C for 10 to 12 h, *dahi* was sweetened with sugar syrup and thoroughly mixed. The resultant *lassi* had 10 days storage life at 5°C in polyethylene pouches.

Kumar *et al.* (1987) developed a *lassi*-type cultured beverage from cheese whey. Skim milk and cheese whey (5:95) were heated (100°C) and acidified with HCl (pH 4.5) to obtain the curd. Curd so obtained was added to separated whey to raise the protein level to 3 percent. At pH 7.0, the mixture was homogenized, pasteurized, cooled (22°C) and inoculated with LF 40 culture. After 16 h incubation, sugar (12.5%) and synthetic pineapple flavour were added. *Lassi* packed in polyethylene pouches had a shelf-life of 6 days at 5°C. The finished *lassi* contained 21 to 22 percent TS, 3.05 percent protein, 17.85 percent carbohydrates (including 12.5% added sugar) and 0.3 percent ash.

Naresh and Prasad (1996) attempted the enhancement of the shelf-life of *lassi* apart from cold storage. Addition of nisin @ 200 or 300 IU/ml and 400 or 500 IU/ml extended the acceptability to 24 and 32 h, respectively, compared to 8 h for control at 30°C. Simultaneously at 20°C acceptability increased from 12 to 24 h and 48 h by adding nisin @ 100 or 200 IU/ml and 400 or 500 IU/ml, respectively. Nisin @ 500 IU/ml could extend acceptability up to 8 to 10 days at refrigerated storage.

*Lassi*-like beverage was developed using *paneer* whey and buffalo milk with pectin and CMC as stabilizers. After neutralization, *paneer* whey (pH 6.6) was mixed with standardized buffalo milk (6% fat), followed by addition of stabilizer, heating (80°C), cooling (30°C), inoculation with NCDC167 culture @ one percent and incubation at 30°C per 14 to 16 h. *Dahi* was then blended along with sugar syrup and flavour. The beverage had 1.35 percent protein, 19 to 36 percent TS, 1.9 percent fat and 4.0 percent lactose. The product with 70 percent whey and pectin CMC in the ratio 0.5:1 at 0.6 percent level was adjudged most acceptable (Mittal, 2003).
Kumar (2004) developed lassi-like beverage from rennet whey. It contained 67.27 per cent whey and standardized buffalo milk (6% fat), followed by addition of 0.85 per cent pectin, 0.13 per cent CMC and 0.15 per cent trisodium expand as citrate stabilizer then hydration for 30 min, heating (80°C/10 min) and cooling (30°C). Two per cent starter culture was added and the mixture was incubated at 30°C for 12 h. The coagulum was blended after the addition of cooled sugar syrup and flavour @ 15 and 0.01 per cent. The beverage had 2.0 per cent fat, 1.85 per cent protein, 12.49 per cent sucrose and 4.54 per cent lactose, its acidity and pH were 0.675 per cent LA and 4.24.

The lassi-like whey-based beverages developed as above were subjected to UHT-treatment. The final results suggested that milk could be replaced by 70% paneer or cheese whey in the preparation of a lassi-like beverage, thus ensuring complete utilisation of large quantities of whey. The product is also amenable to UHT-treatment and has a shelf life of over six months.

5.0 Conclusion

Ancient Vedic texts laud the virtues of fermented dairy products, as validated in modern times by scientific proof. The significance of traditional knowledge, their combination with scientific know-how and the demand from consumers for variety have prompted researchers to look for variations in products such as lassi. The advances in the study of chemical and functional roles of the components of milk have given a new stimulus in rediscovering the age-old secrets of milk and its fermentation.

6.0 Suggested Reading


TECHNOLOGICAL DEVELOPMENTS IN THE PRODUCTION OF SHRIKHAND

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1.0 Introduction
Shrikhand is an indigenous fermented and sweetened milk product of Indian origin and regularly consumed in Gujarat, Maharashtra and certain parts of Karnataka, Madhya Pradesh and Rajasthan. In addition to these places, because of its typical sweet-sour taste, it is becoming popular in other parts of the country. Shrikhand is prepared by blending chakka with sugar, cream and other ingredients like fruit pulp, nut, flavor, spices, color, etc. to achieve the finished product of desired composition, consistency and sensory attributes. Shrikhand has a typical semi-solid consistency with a characteristic smoothness, firmness and pliability that make it suitable for consumption directly after meal or with “puree” or bread. It resembles sweetened Quarg or Quark produced in Germany (Patel and Abd-EL-Salam, 1986). Although largely produced on small scale adopting age old traditional methods, with the growing demand, shrikhand is now commercially manufactured in organized dairy sector.

Shrikhand available in various parts of country has considerable variations with respect to its composition, sensory quality, microbiological attributes and also textural parameters (Sharma and Zariwala, 1980; Upadhyay, et. al, 1984; Salunke, et. al, 2005; Salunke, et. al, 2006). Consumers in Gujarat prefer its sweet variety while those in Maharashtra prefer the tangy / sour variety (Aneja, et. al, 2002). According to the recently amended PFA rules (1954), shrikhand shall contain not less than 8.5 percent milk fat (on dry basis), not less than 9.0 percent protein (on dry basis), and should not contain more than 72.5 percent sugar (on dry basis). Same PFA standards implies to fruit shrikhand as for plain shrikhand except that the fat content in it shall not be less than 7.0 percent of dry matter. In the present paper the technological developments in making shrikhand are discussed.

2.0 Traditional Method of Making Shrikhand
The traditional method of making shrikhand involves the preparation of curd or dahi by culturing cow or buffalo milk with natural starter (curd of the previous batch). After a firm curd is formed, it is transferred in a muslin cloth and hung for 12 – 18 hr to remove free whey. The semi-solid mass obtained is called as “chakka”. The chakka is mixed with required amount of sugar, color, flavoring materials and spices and blended to smooth and homogenous consistency (Upadhyay and Dave, 1977). Shrikhand is stored and served in chilled form. The batch to batch large variation in the quality and poor shelf-life of shrikhand are the serious drawbacks of the traditional method. Generally the recovery of solids in chakka is also low.
3.0 Industrial Method of Making Shrikhand

With a view to overcome the limitations of traditional method, successful attempts have been made to develop an industrial process for the manufacture of shrikhand (Aneja, et. al, 1977). Though many dairy plants in Maharashtra and Gujarat states are now manufacturing shrikhand on commercial scale, the first modern plant was established at the Baroda District Co-operative Milk Producers’ Union Ltd. (Sugam Unit) in Gujarat in 1980. Since then it has been producing and marketing shrikhand under the brand names of “SUGAM” and “AMUL” (Aneja, et. al, 2002). The industrial production of shrikhand involves the following steps:

3.1 Processing of Milk

Normally skim milk is used for making dahi for the manufacture of shrikhand at large scale. By using skim milk, not only fat losses are eliminated, but also faster moisture expulsion and less moisture retention in the curd are achieved (Patel, 1982). Skim milk (0.05% fat and 9% SNF) is heated to 85°C for 30 min. This heat treatment results in denaturation of β-lactoglobulin which in turn interacts with casein on acid coagulation, thereby increasing the yield. Also high temperatures are believed to result in the alteration of proteins in milk which favors the growth and activity of starter culture.

3.2 Starter Cultures

The use of right type of culture is an essential pre-requisite for the manufacture of shrikhand. In one of the earlier studies, Puntamberkar (1968) made use of Lactococcus lactis or Lactococcus cremoris at the rate of 1 – 2 % while Gandhi and Jain (1977) reported the use of mixed culture containing Lactococcus lactis, Lactococcus lactis var. diacetylactis, and Leuconostoc cremoris in a ratio of 1:1:1. Patel and Chakroborty (1985) recommended use of S. thermophilus and Lactobacillus bulgaricus in a ratio of 1:1. However, LF – 40 a culture containing Lactococcus lactis subsp. lactis and Lactococcus lactis var. diacetylactis has received wide acceptance by many shrikhand manufacturers.

3.3 Preparation of Shrikhand

The flow diagram for the industrial method of manufacturing shrikhand (Aneja, et. al, 1977) is given in Fig.1. The LF 40 culture @ 1 – 1.5% is added to milk and the milk incubated at 30 °C for 10 – 12 hr in order to get 0.9% of titratable acidity (TA) in the curd. Dahi is centrifuged in a basket centrifuge (900 x g) for about 90 min to get chakka. Generally separation of whey is performed at a temperature nearer to that at which milk is incubated for dahi making. The measured quantities of chakka, sugar, cream and additives are mixed in a planetary mixer (30 – 40 rpm) for 30 min. it is desirable to keep 5 – 6% fat and 41% sucrose in the finished product (Patel and Chakraborty, 1985).

3.4 Packaging

Shrikhand, being a semi-solid product, is packed in heat sealable polystyrene containers of various sizes ranging from 100 g to 1.0 kg (Patel, 1998). The use of pre-formed polystyrene cups for packing shrikhand limited the packaging capacity to 1000 cups/hr. By
employing a form-fill-seal (FFS) machine up to 6000 cups may be filled / packed hour (Aneja, et. al, 2002).

3.5 Shelf life

The keeping quality of shrikhand depends largely on its initial microflora like yeast, mould and other foreign organisms. Owing to both high acid and sugar levels, shrikhand has a fairly long shelf-life of 35 – 40 days at 8 °C and 2 – 3 days at 30 °C. Deterioration of the product is usually associated with an increased activity of yeast and mold, and proteolytic microflora under refrigeration conditions of storage. Addition of 0.5% potassium sorbate retards the growth of yeasts and molds (Patel, 1998). Prajapati, et al. (1992) reported that post-production heat treatment at 70 °C for 5 min yielded shrikhand with a superior overall quality and a shelf-life of 15 days at 35 – 37 °C. However, to get best shelf-life in the industrial process, thermization of shrikhand at 65 °C / 10 min and its subsequent freezing is most effective. The frozen product can be kept in good condition from six months to twelve months at -18 °C (Aneja, et. al, 2002).

4.0 Manufacture of Shrikhand using UF-chakka

Ultrafiltration (UF) is a pressure-driven, cross-flow membrane system that can simultaneously purify, concentrate, and fractionate organic molecules of a feed stream (Pal, 2003). The applicability of ultrafiltration has widened considerably in dairy industry and probably account for the largest share of installed membrane capacity worldwide. In the traditional and industrial methods developed for manufacturing shrikhand there is considerable loss of whey proteins through the expulsion of whey from chakka. These whey proteins with a high biological value could be recovered in chakka by the application of ultrafiltration (UF) to make the so called UF-chakka. The UF chakka could be handled in the same manner as traditional chakka to make the final product, i.e., shrikhand.

Sharma and Reuter (1992) made a successful attempt to develop UF-chakka for subsequent use in shrikhand preparation using ceramic membrane module. The UF setup was designed with a centrifugal pump of 5,000 litres /hr capacity so as to obtain a velocity of 5 m/sec in the module. The temperature and transmembrane pressure employed during the UF process were 50 ± 2 °C and 0.5 (p_i + p_o) = 4 bars, where p_i and p_o are inlet and outlet pressures of the milk respectively.

The method developed by Sharma and Reuter (1992) is given in Fig. 2. It consisted of heating skim milk in a double jacketed vat with slow agitation up to a temperature of 95 °C for 5 min and then cooling it to 21 – 22 °C. This was followed by inoculating with mixed starter culture (Lactococcus lactis, Lactococcus lactis var. diacetylactis and Lactococcus cremoris) at a rate of 0.1 – 0.15%. It was incubated at 21 – 22 °C for 16 – 18 hr so as to get curd with pH of 4.6 – 4.5 and with a pleasant diacetyl aroma. The coagulum obtained was agitated with slow speed and subjected to ultrafiltration. Whey was removed in the form of permeate. The chakka thus obtained was mixed with 70% fat cream and sugar so as to manufacture shrikhand that contained fat 6%, sugar 41% and moisture 40%. The mixture was then kneaded in planetary mixer at 25 – 26 °C in order to get a smooth paste-like semi-solid
consistency with no feeling of sugar grains. It was reported that there was practically no difference between traditional and UF-shrikhand. The authors claimed two main advantages of adopting UF process for shrikhand making: (a) higher product yield, because of recovery of whey proteins, and (b) easy automation and process control for large scale production.

Md-Ansari, *et. al*, (2006) also developed the technology for the manufacture of shrikhand using UF pre-concentrated skim milk. It involved pasteurization of skim milk (9% TS) at 92 °C for 5 min followed by cooling to 30 °C. The suspended solids were removed by cloth filtration and the milk subjected to concentration using UF membrane. The UF-concentrated skim milk with 11 to 12% TS was used to make *chakka*. This *chakka* after removal of whey had 18% TS. It was reported that this UF-concentrated skim milk *chakka* when subsequently used for making shrikhand resembled conventional shrikhand. However, the milk concentrate with 19 to 20% TS, when directly used for shrikhand making without whey drainage had a curdling time of 9 to 10 hr for reaching 2% acidity. Shrikhand made from this *chakka* was reported to be poor in quality and showed formation of hard particles during pasteurization. Hence, these recommended further studies to improve the quality of shrikhand using UF-concentrated skim milk.

5.0 Manufacture of Fruit Flavored Shrikhand

With the growing interest in the diversification of food products to attract wide consumers, in the recent past we have noticed that many attempts have been made to incorporate different additives into shrikhand. Fruit pulps like apple, mango, papaya, banana, guava and sapota (Bardale, *et. al*, 1986; Dadarwal, *et. al*, 2005) and cocoa powder with and without papaya pulp (Vagdalkar, *et. al*, 2002) have been tried in shrikhand. However, in case of post-fermentation addition of pulps, from the food safety point of view, it is necessary that the fruit pulp intended for addition shall be subjected to heat treatment equivalent to pasteurization.

Bardale, *et. al*, (1986) had reported that shrikhand prepared by incorporating 20% apple pulp had maximum acceptability. However, Vagdalkar, *et. al*, (2002) had reported that shrikhand prepared by adding 5% cocoa powder and 60% pulp was equivalent to the control with regard to sensory attributes. In a study conducted by Dadarwal, *et. al*, (2005) it was reported that the sensory properties of shrikhand prepared by incorporating 5% and 10% fruit pulp (banana, guava, and sapota) along with 40% sugar (w/w) to milk and in *chakka* respectively was at par or superior than the conventional shrikhand without fruit pulps.

6.0 Manufacture of Direct Acidified Shrikhand

The traditional technology of shrikhand making is cumbersome and time consuming as about 12 to 15 hr are required for complete coagulation of milk and another 6 to 8 hr for expulsion of whey. Use of direct acidification in manufacture of Shrikhand would reduce the processing time considerably, save the cost due to culture maintenance and propagation, and eliminate all the problems related to starter culture.
The attempts made to manufacture shrikhand by direct acidification by Patel and Chakraborthy (1985) did not produce desirable results as the shrikhand made by direct acidification had grainy texture. However, Biyabani, et. al, (1998) had attempted to develop directly acidified shrikhand by suitably modifying the earlier reported procedure to overcome the problem of hard grainy texture. It involved standardization of buffalo milk to 6% fat and bringing to boil followed by addition of disodium hydrogen phosphate at a level of 0.1%. Then cooled to room temperature followed by chilling to 5°C. Using 50% (v/v) lactic acid solution, the pH of the chilled milk was adjusted to 4.8. The acidified milk was then allowed to set in an incubator at 37°C for 3 hr. Then the chakka was obtained from the well set curd in the similar manner to that of conventional chakka. The directly acidified chakka was then added with 40% ground sugar and 2% cardamom powder and mixed thoroughly. The mixture was then passed through muslin cloth to obtain Shrikhand. However, it was reported that the overall acceptability of directly acidified Shrikhand was significantly less than that of conventional shrikhand.

7.0 Manufacture of Shrikhand using Sugar Replacer

With the changing lifestyle patterns, diseases like obesity, diabetes and cardiovascular diseases have become major concern worldwide. Diabetes mellitus is a descriptive term covering a heterogeneous group of chronic metabolic disorders, all characterized by elevated blood glucose concentrations. The production of sugar free products can enable diabetic people to relish the dairy products without affecting their blood glucose levels. Further, the trend of low fat and low sugar foods is spurred by calorie conscious section of modern society. In this context, various low-calorie sweeteners and zero-calorie sugar replacers have been used in formulating traditional Indian dairy products by replacing sugar either partially or completely (Pal and Prabha, 2005).

Singh and Jha (2005) had developed a technology for the production of shrikhand by partial replacement of sugar using Raftilose®, a commercial sugar replacer and dietary fiber. It involved separation of milk followed by pasteurization at 90°C for 16 seconds and cooling to 37±1°C. Then the milk was inoculated with yoghurt culture @ 2% and incubated at 42 ± 1°C. Once the desired pH of 4.3 was attained the curd was transferred into a muslin cloth and chakka was obtained by draining whey. It was reported that the sensory attributes were most acceptable when sugar and Raftilose® were added @ 12.5% and 4% respectively to the product. These workers also reported that the calorific value of conventional and developed shrikhand were 232.05 and 127.86 kcal/100g respectively, thereby enabling about 45% reduction in total calorific value.

8.0 Conclusion

Shrikhand, being a refreshing fermented traditional dairy product especially in summers, is gaining popularity in different parts of the country. Because of growing awareness of hygiene and food safety, the mechanized units for shrikhand making has been identified and used for commercial production. Rapid developments in the processing of milk led to the application of technologies such as ultrafiltration, direct acidification, etc. in shrikhand making for enhancing the yield and reduce the time involved in preparation. For
attracting a wide segment of consumers, diversification in the preparation of shrikhand and shrikhand-like products is carried out by incorporating fruit pulps and other food additives.

9.0 Suggested Readings


Fig. 1. Industrial method of making shrikhand.  
(Aneja, et. al, 1977)
Fig. 2. Method of making shrikhand using UF-chakka
(Sharma and Reuter, 1992)
1.0 Introduction

India has the unique tradition of producing a variety of indigenous milk products. Pattern of milk utilization in the country indicates that about 37.7% of the total milk produced is being converted into various types of indigenous milk products (Aneja and Puri, 1997). India’s total production of chhana, a heat and acid coagulated product, is estimated at 2 million tones and valued at Rs. 7000 million (Aneja et al., 2002). The product is used extensively as the base and filler for the preparation of a large variety of Indian delicacies namely, rasogolla, sandesh, cham-cham, rasmalai, pantooa, rajbhog, chhana-murki and many more such products.

Table 1: Classification of Indigenous chhana based milk sweets

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked channa-juicy products</td>
<td>Rassogolla and its derivatives</td>
</tr>
<tr>
<td></td>
<td>A. Rassogolla- boiled in sugar syrup</td>
</tr>
<tr>
<td></td>
<td>B. Rossomalai- boiled in syrup and transferred to sweetened condensed milk</td>
</tr>
<tr>
<td></td>
<td>C. Rajbhog- boiled same as rasogolla, but stuffed with khoa, spices and cardamom</td>
</tr>
<tr>
<td></td>
<td>D. Chamcham- boiled same as rasogolla but shaped cylindrical and decorated with grated khoa</td>
</tr>
<tr>
<td></td>
<td>E. Danadar- boiled in very thick, almost crystalline, sugar syrup.</td>
</tr>
<tr>
<td>Uncooked chhana</td>
<td>Katcha golla</td>
</tr>
<tr>
<td>Cooked channa -dry products</td>
<td>Sandesh- medium moisture content</td>
</tr>
<tr>
<td></td>
<td>Koda pak sandesh- very low moisture content.</td>
</tr>
<tr>
<td>Fried channa pieces coated with sugar</td>
<td>Chanar murki</td>
</tr>
<tr>
<td>Channa mixed with coconut mince</td>
<td>Narkel sandesh</td>
</tr>
<tr>
<td>Channa mixed with flour and khoa juicy product</td>
<td>Dry product-mixed sandesh</td>
</tr>
<tr>
<td></td>
<td>Gulabjam, langcha, kalajam, channar jeelabi</td>
</tr>
<tr>
<td>Channa dried, drained and smoked and cut into small hard pieces</td>
<td>Surpi- a product of hill areas</td>
</tr>
</tbody>
</table>

According to PFA chhana means the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It shall not
contain more than 70.0 per cent moisture and the milk fat content shall not be less than 50.0 per cent of the dry matter (PFA, 1954).

2.0 Principle involved in Chhana Manufacturing

Production of chhana involves destabilization of casein by addition of dilute acid to milk at relatively higher temperature. Acid affects the stability of casein directly by disturbing the charges carried by the particles and indirectly by releasing the calcium ion from colloidal calcium-caseinate-phosphate complex. The destabilization results in formation of large structural aggregates in which milk fat, serum proteins and other constituents get entrained.

3.0 Method of Manufacturing

3.1 Traditional Method

In traditional production of chhana, a small portion of boiled milk (0.5-1.0 kg) is transferred to a small coagulating vessel. The required amount of coagulant (usually the previous day’s old chhana whey) is added to the hot milk and stirred with a wooden ladle till the coagulation is complete. The vessel contents are then poured over a piece of clean muslin cloth held over another vessel in which the whey gets collected. The coagulation process is repeated till all the milk is converted into chhana. The muslin cloth containing the curd mass is hung to further drain out whey and to cool the chhana simultaneously (Aneja et al., 2002).

3.2 Industrial Method

The process for industrial production of chhana is similar to the traditional method with the exception that whole milk is coagulated in a single lot by adding coagulant slowly with constant stirring of milk till the clear whey appears. The coagulated chhana mass is then collected and strained through a muslin cloth.

3.3 Continuous Method

To overcome the problems of small scale, attempts have been made to mechanize chhana production. A prototype machine, with 40 kg chhana per hour capacity, has been developed by Aneja et al. (1982). The equipment consists of various components viz. a balance tank, injection chamber, holding coil, cooling chamber and strainer. A brief procedure of the process is as follows:

Standardized cow milk is pumped from a balance tank (at the rate of 250 lit/hr) to an injection chamber where culinary live steam (at 1 kg/cm² pressure and at the rate of 65 kg/hr) is directly injected into the milk. Steam gets completely condensed in milk and raises its temperature to 90-95°C. Thereafter, milk is brought in contact with sour whey, the quantity of which is regulated manually in proportion to the rate of milk flow. The mixture of milk and whey is circulated through a holding coil (8m x 10mm) to facilitate complete coagulation of milk. The coagulated product, along with the whey is then pumped to a double-jacketed cooling tank, where it is cooled down to room temperature. Finally, the product is directed to a mechanical strainer, a double jacketed inclined sieve, where it is
drained thoroughly. Chhana with 55-65 per cent moisture is discharged through the outlet and collected in the basket. Drained whey is transferred to a separate tank for subsequent use.

4.0 Process Innovations in Chhana Manufacturing

4.1. Chhana from Concentrated and Dried Whole Milk

Good quality of chhana from concentrated and dried whole milk after reconstituting it to 15 per cent TS has been produced (Kawal, 1979; Singh, 1991).

4.2 Chhana Powder

Chhana powder has been produced using tray, roller and spray drying processes (Tewari and De, 1976). The product can be reconstituted into chhana for preparation of Sandesh. Rasogolla, however, could not be prepared as balls disintegrated during boiling in sugar syrup. Chhana powder is reported to have a shelf-life of 2 and 4 months under air tight and gas packed conditions respectively.

4.3 Continuous Dewatering of Chhana Coagulum

The batch method of production suffers from the drawbacks of non-uniform quality, long processing time, low keeping quality and insufficient utilization of energy. The application of Transverse Jet Mixer-Reactor for continuous coagulation improves instant mixing and coagulum formation. The energy saving by use of regenerative heating through plate heat exchanger is also employed. For continuous dewatering, Sinha and Agarwala (2002) used endless moving nylon filter conveyor of 28, 40 and 50 mesh size with dewatering periods of 10, 20 and 30 min. For the acid flow rate of 45L/h (0.6% citric acid solution) the milk flow rate was found to be 125-135 L/h in order to achieve a pH of 5.4 in whey. It was concluded that the machine could be adopted for chhana making with throughput of 25-30 kg/h, without altering the machine parameters.

4.4 Chhana by Ultrafiltration

The application of ultrafiltration in chhana manufacture has been observed to increase the product yield because of recovery of additional whey proteins (Sharma and Reuter, 1991). The diafiltration step during ultrafiltration reduces the whey constituents (mostly lactose and minerals). Easy automation, uniform quality, improved shelf-life, nutritionally better product and flexibility of operation are some of the main inherent advantages of UF process.

An attempt has been made by Kumar et al (2005) to improve the quality of chhana developed by UF process. Cow skim milk was ultrafiltered (UF) and diafiltered to an optimum of 23.88% TS. The required quantity of 63-65% fat fresh cream was added to the UF retentate for standardization of fat. The UF chhana prepared from this retentate mixture, employing the traditional approach (heat treatment at 90°C for 5 min and coagulation with
10% citric acid at 70°C and pH 5.5), was harder, retained less moisture and unsuitable for making of sweets (rasogolla and sandesh). Lowering the coagulation temperature (60, 50 and 40°C) improved the softness of UF chhana to some extent but significantly increased the total solid losses in whey. An innovative new approach involving the addition of a coagulant to the UF retentate mixture at room temperature and then heating to coagulation temperature (optimum of 60°C) resulted in production of a softer chhana with higher moisture content. Moreover, this chhana was suitable for making sweets (rasogolla and sandesh) and had higher yield (12.92%) and total solid recovery (10.89%) compared to the traditional chhana. Less total solid losses in whey were also observed compared to the UF chhana prepared using the traditional approach. Slow stirring (60-80 rpm) during heating and coagulation of UF retentate mixture yielded lower moisture (54.53%) content in chhana compared to 56.93% moisture with rapid stirring (130-150 rpm). The standardized UF chhana met the PFA standards and was comparable to the traditional chhana organoleptically. Rasogolla and sandesh, prepared with the UF chhana produced using the modified process, scored liked moderately to liked very much on sensory evaluation.

4.5 Use of Herbal Coagulants

Singh, et. al, (2005) used two herbal coagulants (papaya extract and ginger extract) for the preparation of chhana. The sensory (flavour, body and texture, colour and appearance, and overall acceptability) and chemical (total solids fat, protein, lactose and ash) qualities of the chhana produced using herbal coagulants was not found to be par with the conventional chhana.

5.0 Chhana Based Sweets

5.1 Rasogolla

Rasogolla is a delicacy, stored and served in sugar syrup. In size and shape, it resembles ping-pong ball. Snow-white in colour, it possesses a spongy, chewy body, and smooth texture. Rasogolla is prepared from soft, freshly-made cow milk chhana.

5.1.1 Rasogolla from dried milk

Because of limited shelf life of chhana lasting only few hours and shortage of milk during the lean season, traders have to face many difficulties. To overcome such problems Singh (1991) standardised a method for preparation of good quality rasogolla using dried milk. The recommended technology involves: Dissolving the whole milk powder to 17 percent total solids, heating the reconstituted milk to boil, filtration, cooling to 70°C; coagulation with either 1.0% citric acid or lactic acid solution (70°C) at pH of coagulation of 5.5, delayed straining (15 min), cooling the coagulum contained in muslin cloth to room temperature, by immersing in running tap water, draining for three and half hours, kneading the chhana to smooth consistency, rolling into balls and cooking it in boiling sugar syrup of 50% concentration for 20 min and finally transferring the cooked rasogolla balls to hot (60°C) sugar syrup (40%) and cooling to ambient temperature before refrigeration storage.
5.1.2 Dried rasogolla mix

Technology for production of dried rasogolla mix has been standardised (Pal et al., 1993). Skim milk is concentrated to required T.S. level by using ultra and diafiltration process, calculated amount of fat is added to the retentate before spray drying it. Certain additives and binders are dry blended in the retentate powder to get dried rasogolla mix. Rasogolla prepared out of dried rasogolla mix is reported to have balanced flavour and spongy texture.

5.1.3 Rasogolla from modified buffalo milk

Rasogolla prepared from buffalo milk is usually hard and lacks sponginess, as well as desired body and texture. Ramathilagam and Subramanian (2005) investigated the suitability of buffalo milk for the preparation of rasogolla, by carrying out certain modifications in buffalo milk. It was found that lactic acid (0.5%) is the best coagulant that can be used for the preparation of rasogolla from buffalo milk and rasogolla prepared from chhana substituted with 25% casein is the most preferred combination. Organoleptic evaluation was also in confirmation with the above fact and the control and substituted samples were comparable with the market sample with better quality.

5.1.4 Use of various stabilizers

In addition to the type of milk, quality of chhana and use of an appropriate proportion and type of binding material also play an important role in deciding the body and textural properties of rasogolla. Shelke et al (2003) studied the effect of various starches as binding material on quality of rasogolla. Chhana prepared from cow milk was admixed with active culture of *Saccharomyces cerevisiae* with 0.6% baker's yeast, 1% sucrose and 3% refined starches as per treatments (vis., wheat, tapioca, rice, maize and water chestnut). Chhana dough was incubated at 35°C for one hour and smooth balls were cooked in 50% sugar syrup. After cooking, the Rasogolla balls were stored in sugar syrup for analysis of voluminosity, sponginess, porosity and force disintegration value (pressure). Rasogolla was judged for overall acceptability by a panel of judges. Results showed that Rasogolla with rice starch comparatively had maximum voluminosity, force of disintegration, porosity, and sponginess was most acceptable with uniform surface.

5.1.5 Protein-enriched rasogolla

Apart from improving the textural properties of rasogolla, studies have also been conducted on the enhancement of nutritional value of the sweet delicacy. Mathur and Singh (2001) developed a technology for protein-enriched rasogolla by using Soya- protein isolate, deoiled soya-flour and skim milk powder added to cow milk, buffalo milk, goat milk and mixed milk. Maximum chhana yield was observed through the addition of 1.5% incremental protein in the form of deoiled soyaflour to various milk types. The protein content of rasogolla increased by 47%, as compared with the control, when 1.5% soyaprotein isolate was added to mixed milk. The sensory attributes of the protein-enriched rasogolla were comparable with the control. The results suggest new dimensions in the protein-enrichment
of filled rasogolla and rasogolla analogues, by overcoming the reported beany flavour when soyamilk is used.

5.1.6 Sugar-free rasogolla

Jayaprakash (2003) developed a technology for the manufacturing of sugar free Rasogolla using different artificial sweeteners. On the basis of sensory evaluation, the best combination of the sweeteners, which gave the most acceptable product, was 41.77 per cent sorbitol and 0.08 percent aspartame.

5.2 Sandesh

Sandesh is the most popular chhana-based sweet delicacy of the eastern parts of India, especially West Bengal. Utilization of chhana for sandesh production is greater than for all other Bengali sweets, including rasogolla. It is claimed that about 80 percent of chhana produced in Kolkata is converted into sandesh (Aneja et al, 2002). Chhana obtained with citric acid is usually preferred for the manufacture of sandesh. Sandesh is known for its palatability, aroma and as a rich source of milk proteins, fat, sucrose and fat-soluble vitamins. It has a firm body and smooth texture.

5.2.1 Mechanised production of sandesh

Kumar and Das (2003) optimized the processing parameters for the mechnised production of sandesh. For the drainage of whey basket centrifuge was used. Planetary mixer at the speed of 60 rpm for 5 min was employed for mixing of chhana and sugar. Kneading of chhana sugar mixture was done in a stainless steel screw kneader. The chhana sugar mixture after mixing was fed into the hopper of the kneader. The gap between the screw tip and end cover was adjustable by rotation of the end cover. Passage of chhana sugar mixture through this gap carried out the kneading. The kneader screw was rotated at 75 rpm. In continuous method of sandesh making, initial moisture content of chhana, cooking temperature and time of cooking are the three important parameters, which decide the final quality of the product. Optimised values of process parameters obtained using Response Surface Methodology were, 75°C cooking temperature, 4.6 min. cooking time and 48% initial moisture content.

5.2.2 Sandesh from modified buffalo milk

Modification of buffalo milk using various stabilizers has been investigated by Sen and Rajorhia (1999) to improve the quality of sandesh. Two stabilizers viz., carboxymethylcellulose (CMC) and guar gum at different levels were added in buffalo milk. From the sensory scores of sandesh, it was concluded that the treatment of buffalo milk with guar gum gave better results than CMC, whereas, the control or untreated sandesh samples had the lowest ratings for body and texture including overall acceptability.

5.3 Rasmalai

Rasmalai is a chhana based sweet prepared essentially by suspending rasogolla in sweetened condensed milk. Milk (1.0 Kg) is evaporated in open pan to about one-half its
original volume (500 g). At this stage sugar, at the rate of 4.0 per cent of original milk, (40 g) is added. Evaporation is continued at slow heat till the content is reduced to about one-third its original volume (350 g). Heating with added sugar imparts pleasant flavour and palatable taste to the end product. Subsequently rasogolla, preferably made in flat circular shape rather than the usual round ball, is added to it and heating continued for a further period of 2-5 min. The container is removed from fire and the content is allowed to cool to room temperature, chilled and stored under refrigeration. The product is relished more while it is chilled. The product has limited keeping quality and should be consumed within 3-5 days.

5.4 Chhana - Murki

As the name implies, chhana murki is a chhana based sweet. The sweet is very popular in North India. Buffalo milk is preferred for the preparation of this sweet. In the absence of any standardized method for production of this sweet, wide variations are observed in its physico-chemical, microbiological and sensory quality. According to one recipe of this sweet, 250 g chhana, 125 g sugar, 45 g water and a few drops of flavour (kewara) are used in its preparation.

5.5 Cham-Cham

‘Cham-cham’ is another chhana based sweet. Process of manufacture of this sweet is the same as that of rasogolla. However, in the preparation of this sweet, instead of making round balls it is given cylindrical shape. A delicacy in this sweet is prepared by smearing grated khoa or coconut powder. The composition, yield and keeping quality of the sweet is almost similar to that of rasogolla.

5.6 Khirmohan

Khirmohan is a popular sweet in eastern India and is preferred for its texture and taste. For its preparation, chhana is kneaded alongwith 1-4 per cent wheat flour into a smooth dough, portioned and rolled into small balls. The balls are flattened to a circular shape and processed like rasogolla. After cooking, these balls are dipped in concentrated milk, removed and smeared with grated khoa.

5.7 Chhana Based Table Spreads

Very few attempts have been made in this area of product diversification. Tewari et al., (1991) took an initiative for the manufacturing of chhana spread. The process involved in production of chhana-spread included preparation of chhana. Chhana obtained was broken into small pieces and transferred to a domestic mixer where it was made into a paste with the addition of water. For every 100 g of cow chhana approximately 10 ml of water was added while 20 ml of water was required for buffalo chhana. Salt @ 1.0-1.5% was added during grinding. An acidifying agent was also added to lower the pH to 5.1-5.0. For this purpose 1 part of citric or lactic acid dissolved in 1 part of water was added @ 0.8-1.0 ml per 100 g of spread.
A low-fat sweetened dairy spread was developed by Babubhai (1999). In this the source of protein was chhana and SMP. The other constituents of serum phase included ground sugar and maltodextrin.

Reddy et al (2000) standardized another protein-enriched table spread using chhana as base along with butter. Skim milk chhana and butter were blended in 70:30, 60:40 and 50:50 (w/w) proportions and mixed and worked thoroughly in a Waring blender at 15-20°C for about 30 min to yield a homogenous mass. Salt was added @ 2% (w/w). Based on the various physico-chemical and sensory attributes, use of 40% chhana was reported to be best suited for the preparation of spread.

6.0 Conclusion

Chhana and chhana-based products have been prepared and marketed in India from times immemorial. But still they are produced in the unorganized small sector in India wherein modern concepts of hygiene, food safety, food quality are not given due importance. The turnover in terms of money and quantity as well as market for chhana based products exceeds those of many western dairy products. Scope of innovation and value addition is also great. Organized dairy sector which has hitherto shown no interest in production of these products needs to take up its production mainly for export.

7.0 Suggested Readings


1.0 Introduction

Huge Indian population - in the country and abroad - and growing economy are offering good potential for the growth of market for Indian traditional dairy products. As such, the industry is looking at various ways of large scale manufacture and organised marketing of these products, but low shelf life and wide variation in quality characteristics have become the major impediments. To meet the growing demand, number of local halwais have increased and the existing ones have extended their businesses. Consuming and offering sweets on festival and auspicious occasions is the hallmark of Indian culture, so Indian diaspora have a natural longing for these products and their needs have to be met mostly by export from India, which means the products have to be produced under strict hygienic code and should have a fairly long shelf - life.

In order to strengthen research on traditional Indian dairy products, ICAR has accorded priority to R&D of these products, which has also become one of the thrust areas of Indian research institutes. Most of the work carried out on our traditional products deals with characterisation, standardisation of method of manufacture and improving shelf life. Methods like retort processing, fermentation etc. have been tried out for improving their shelf life depending on the nature of the product; some of these products are described here.

2.0 Retort Processed Milk Desserts

Retort processing involves in-package heat treatment of foods to above boiling point of water at high pressures (2 – 3 atmospheres) in specialised vessels called retorts using heating media such as water, steam, steam & water, steam & air etc.

2.1 Payasam

Payasam is a traditional sweet delicacy of South India prepared especially on auspicious occasions. Payasam has many varieties with specialities and distinct characteristics attributed to the area – specific traditional method of preparation. They have a wide range of composition, the solids content ranging from 30.9 – 51.9 %, and sucrose content from 17.7 – 32.0 % (Unnikrishnan, et. al, 2000). Their shelf - life varies from 1 – 2 days at room temperature. Some efforts have been made to improve shelf life by retort processing.
2.1.1 Palada payasam

Palada payasam is a sweet delicacy popular in Kerala. Attempts were made to enhance the shelf life of Palada payasam to a commercially viable level by retort processing method. Pasteurised, toned milk was added with sugar and was concentrated to desired level in a steam jacketed kettle. Ada flakes previously soaked in hot water at 90°C for 10 min and washed with cooled water, were kept ready. Desired quantity of the washed ada flakes and pre-concentrated milk with added sugar were dosed into individual retort pouches using wide mouth funnel. The pouches were sealed and were subjected to $F_0$ treatment of 10.10 and 13.45 in an over pressure retort processing system (Fig. 1). Storage studies indicated that the products were acceptable up to the end of 28 days at 37°C. However, there was decrease in pH and increase in acidity, HMF content, viscosity during storage. The microbial evaluation indicated that the product was commercially sterile as no microbial growth was observed during 28 days of storage.

![Flow diagram for production of Palada Payasam](image)

2.1.2 Gasa gase (poppy seeds) payasam

A technology of retort processed gasa gase payasam was developed as shown in Fig. 2. The products prepared by this method were stored at 37°C to evaluate the shelf life. During storage, various physico-chemical, rheological, microbiological and sensory changes were monitored at weekly intervals. The product was found to be acceptable till the end of 6 weeks at 37°C. However, there was marginal change in pH, acidity, HMF content and viscosity during storage. The sensory scores of colour and appearance, body & texture, flavour and overall acceptability were in ‘like very much’ range. Based on the results it was
concluded that a ready-to-eat gasa gase payasam of shelf-life of at least 6 weeks at 37°C could be prepared by retort processing at 6 or 9 or 12 F-value (Geetha, 2005).

Roasted gasa gase (100 parts) and rice (25 parts)
↓
Soak in water for 10 – 15 min
↓
Add grated dry coconut (50 parts)
↓
Grind to fine paste
↓
Add jaggery (600 parts) syrup and cook for 5 min
↓
Add milk (600 parts) and cardamom powder (10 parts)
Filling into retort pouches (200 g)
↓
Sealing of pouches
↓
Retort processing in an overpressure retort (F₀ value 6.0, at steam pressure of 1.04 bar)
↓
Cooling of pouches in tap water
↓
Gasa gase payasam

Fig. 2 Flow diagram for production of retort processed Gasa gase payasam

2.1.3 Ready-to-drink gasa – gase payasam

Method for the preparation of a low fat, ready-to-drink sterilized Gasa-gase payasam with improved shelf-life was also developed (Fig.3) (Nath, et. al, 2003). Sensory evaluation of the product revealed that the product was comparable to the traditionally made payasam in which dry copra and whole milk were used in place of desiccated coconut powder and skim milk respectively. The product contained less than 2.0 % fat compared to 4.0 % fat in the traditional product. The sterilized payasam had a shelf-life of about three months at ambient temperature.

2.2 Kheer

Pasteurised toned milk is preheated and preconcentrated, and sugar @12% on liquid milk basis was dissolved in it. Basmati rice was washed separately with cold tap water and soaked for about 30 min at 23°C. The preconcentrated milk with added sugar was taken in a retort pouch to which weighed quantity of soaked basmati rice was added along with chopped pieces of dried fruits and flavouring. The pouches were sealed and retort processed at 12.5 – 13.7 F₀ – values. After the processing, the pouches were cooled in tap water. The resulting payasam had a shelf-life of about 4 months at 37°C (Jha, 2000).
Gasa-gase (50 g) + Rice (25 g)
↓
Soak in water for 10-15 min ← Desiccated coconut powder (25 g)
↓
Grind to fine paste (600 ml water)
↓
Filter ← Retentate
↓
Filtrate ← Add skim milk (250 ml) and sugar (200 g)
↓
Cook for 5 min
↓
Add sugar coated cardamom powder
↓
Fill in bottles and sterilize at 121°C/20 min
↓
Ready-to-drink Gasa-gase payasam

Fig. 3. Flow diagram for production of ready-to-drink Gasa-gase payasam

Basmati rice ↓ Pasteurised toned milk
Washing (tap water) ↓ Preheating ↓ Sugar (12% on raw milk basis)
Soaking (23°C/30 min) ↓ Preconcentration ↓ Chopped dry fruits and flavouring
↓ Dosing into retort pouches (RMS : 0.36 – 0.4)
↓ Sealing of pouches
Cooling cum sterilisation
In overpressure rotary retort (Fo value 12.5 – 13.7)
↓ Cooling of pouches in water
↓ Kheer

Fig. 4 Flow diagram for production of retort processed Kheer
2.3 Basundi

Attempts were made to enhance the shelf life of basundi by retort processing. Basundi was filled in flexible retort pouches and subjected to different heat treatments of $F_o$ values of 3.0, 4.0 and 6.5 in an overpressure rotary retort processing system. It was concluded that $F_o$ value of 3 with rotary mode at 2 RPM would be sufficient to produce commercially sterile basundi in ready-to-use form (Raghavendra, 2005).

3.0 Retort Processed Paneer Curry

The process for preparation of retort processed paneer curry as described by Sreedhara (2004) is as follows: The tomatoes were washed thoroughly under running water. Cut paneer was first fried in oil till the colour changed to golden yellow and kept aside. Peeled onions were boiled in water for 15 min and ground along with fried and powdered jeera and ani seeds. Washed tomatoes were also boiled separately and ground with coriander powder, chilli powder and turmeric powder. Oil was heated in a pan and the onion paste was thoroughly fried, tomato puree was added and simmered for 5 min, garam masala and common salt were added and the heating was stopped. Butter was added at the end and mixed well. Fried paneer cubes were then mixed with the gravy in 1:5 ratio and sterilised in retort pouches 240 g per pouch. The product was retort processed at 4.7, 6.3 and 7 F-values. The retort processed product was found to keep well for one month period studied at 37°C without significant changes in physico-chemical and sensory changes.

4.0 Fermented Products

4.1 Kadhi

Kadhi is one of the ethnic fermented food products which is popular in most parts of our country and is produced by using various ingredients like dahi, Bengal gram flour, spices etc. The limited shelf - life of kadhi at room temperature is an impediment for taking the product for wider marketing. Attempts were made to produce long life kadhi at room temperature by adopting retort processing (Fig.5). Technology for production of kadhi was standardised with respect to various parameters like fat and SNF, acidity of the curd, lactic culture and Bengal gram flour level (Manohar, 2005). Two hundred grams of kadhi was filled in flexible retortable pouches and were subjected to $F_o$ treatments of 3.0 and 5.0 in a over pressure rotary retort steriliser. The kadhi samples were found to be acceptable at the end of 5 weeks without any significant sensory, chemical, rheological and microbiological changes. Based on the results obtained, it is concluded that a commercially sterile kadhi in ready-to-use form can be prepared by packing it in a flexible retortable pouch and subjecting it to $F_o$ treatment of 3.0 in a over pressure rotary steriliser system.

4.2 Kalan

Based on the information collected through a survey, kalan was found to be one of popular varieties in Kerala. It is a dahi based product and has a free flowing to semi-solid consistency with variable amounts of cooked vegetables. Kalan has a shelf - life of 3-5 days at room temperature. By packaging in flexible multilayer pouches (200 g) and keeping in boiling water bath for 10 min, the shelf - life was found to be enhanced to about 3 months at room temperature (Nath, et. al, 2004). The detailed process has been depicted in Fig.6 below.
Receiving milk  Bengali gram flour (50 g) and chilli powder (5 g)
↓  ↓  ↓  ↓  ↓  ↓  ↓  ↓  ↓
Standardisation  Sieving  Paste preparation with water
Heat treatment  Cooling  Inoculation  Mixing  Heating with continuous stirring
↓  ↓  ↓  ↓  ↓  ↓  ↓  ↓
Paste preparation with water
Incubation  Dahi (1000 g)  Addition of turmeric powder (0.1 g) and salt (10 g)
↓  ↓  ↓  ↓  ↓  ↓  ↓
Boiling (10 min)
Seasoning with ghee (30 g), onion (50 g), jeera (1.5 g), mustard (1.5 g) spices etc. coriander and Methi leaves (10 g) → Kadhi

**Fig. 5** Flow diagram for production of retort processed Kadhi

Concentrated dahi (200 g)  Elephant yam (140 g) and peeled raw banana (65 g)
↓  ↓  ↓  ↓  ↓  ↓  ↓  ↓
Add 400 ml water  Cutting into pieces (1 inch)
↓  ↓  ↓  ↓  ↓  ↓  ↓
Mixing in grinder for 2 min  Shallow frying in ghee –
↓  ↓  ↓  ↓
Boiling for 5 min  Pressure cooking for 5 min at 1kg
↓  ↓
Addition of fenugreek powder (2.5 g)  Addition of paste made of coconut grating (50 g),
green chillies (10 g), jeera (2 g) to the cooked vegetables
↓  ↓
Seasoning with mustard, red chillies and curry leaves in coconut oil
↓  ↓
Boiling for 2 min
↓  ↓
Kalan

**Fig. 6** Flow diagram for production of Kalan
4.3 Concentrated Dahi

Concentrated dahi was prepared by open pan concentration by Reddy (2006). The process is as follows: Dahi was taken in a SS vessel and heated with constant stirring to 3:1 concentration. It was packed in retort pouches and kept in boiling water bath for 20 min. Storage studies indicated that it kept well for 45 days at 30°C. The disadvantage of this process is that it destroyed microorganisms that give the product its therapeutic characteristics. However, when dahi is used for manufacture of culinary products, it is invariably cooked with other ingredients causing the destruction of culture organisms. The concentrated dahi could be used for preparation of kadhi, kalan and kichati (dahi based culinary items).

4.4 Curd Rice

The shelf life of curd rice is less than 24 h at 30°C. A technology of production of curd rice with a commercially viable shelf life was thus developed (Balasubramanyam, et. al, 2004). Different varieties of rice, starter cultures and ingredients were tried and their effect on curd rice quality and shelf-life were studied. The standardised process involved boiling of toned milk, cooling, inoculation with yoghurt culture at 1% and mixing with cooked rice prepared by using Sona Masoori variety 0.7:1.0 ratio. The mixture was added with 1% common salt and packed in polythene pouches (200 g) and incubated at 37°C for 14 - 16 h. At the end of incubation period the acidity in curd rice samples was of the range of 0.48 – 0.54% LA. The lactic count varied between 62 x 10^4 and 78 x 10^4 / g. The product was found acceptable up to 5 days of storage at 37°C. All the curd rice samples irrespective of the culture used stored well up to 8 days at 5°C. Use of seasoning materials like mustard seeds, coriander leaves, curry leaves and chillies during curd rice preparation improved the acceptability, but decreased the shelf life to 4 days at 37°C. Attempts were made to incorporate wet ginger at different levels to evaluate its effect on sensory quality and shelf-life of curd rice. The ginger was seasoned along with other materials and raw milk was added to it and boiled for 2-3 min. This enabled extraction of flavour and other compounds into the milk. The milk was then used for the curd rice preparation as per the standardised method. It was found that the ginger added curd rice had a shelf-life of 7 days at 37°C storage and 12 days at refrigerated temperature (4-6 °C). The acidity and a_w of fresh curd rice were 0.54% LA and 0.994, respectively. The culture, pH and natural preservatives like ginger have been identified as probable ‘hurdles’ for the improved shelf-life of curd rice prepared by the standardised process.

5.0 Dry Mixes

5.1 Palada Payasam Dry Mix

Unnikrishnan, et. al, (2003) developed a method for palada payasam dry mix, which has been commercialised. In this method, ada flakes (prepared using rice flour) were boiled in water with and soaked for about an hour. With occasional stirring, water is decanted and the soaked ada is washed 2-3 times with cold water. To this, milk and sugar are added and heated in a steam kettle to a pasty mass. At this stage, sugar solution (prepared and kept separately) is added to the kettle and further heated with constant scraping. Then, powdered
sugar is added and thoroughly mixed to get a dry mix. This mix packed in LDPE pouches has a shelf-life of about a year at ambient temperature. Palada payasam of required consistency could be prepared by cooking 200 g of the dry mix in half litre of toned milk for about 12 min. The dry mix has a solids content of 50.8%, fat 3.6%, protein 4.2%, lactose 5.0%, sucrose 31.2% and starch content of 4.6%.

In another method, ada flakes, ground sugar and skim milk powder were dry blended in 15: 60: 25 proportions. The sugar used in the mix contained 25% caramelised sugar which improved the flavour of the final product. Payasam could be prepared from the mix by cooking 44 g of the dry mix in 100 g of water for 10 min. The desired amount of fat was added during cooking in the form of cream (Rai, et. al, 2002).

5.2 Avalakki (Beaten Rice) Payasam Mix

Avalakki payasam is a popular delicacy in Karnataka and Kerala. The cereal ingredient used in this payasam is Avalakki (beaten rice). The product is fine flowing, low viscous with suspended cooked beaten rice flakes and coconut gratings. It has a pleasant cooked flavour. The traditional method of preparation involves deep frying of beaten rice (300 g) in ghee followed by cooking in milk (2 lit). The product is sweetened with sugar (400 g) and flavoured with cardamom and saffron. Nuts and raisins may be added to garnish the product. The product has following proximate composition (%): total solids – 35.2, the suspended solids – 8.8, fat – 3.7, protein – 2.8, lactose – 3.8 and sucrose - 17.7. Avalakki payasam has a low shelf-life (< 24 h at room temperature). Therefore, several attempts are made to develop a ready-to-reconstitute dry mix.

The following method involving drying of soaked beaten rice along with milk and sugar was found to be suitable to prepare a dry mix. One fifth of the soaked beaten rice used for the final preparation along with milk and sugar (80 g) was concentrated in a steam kettle to a high viscous semisolid form. Sugar syrup and remaining wet flakes were added to the kettle and vigorously stirred to get the mix in the dry form.

Payasam could be prepared by boiling the dry mix (225 g) in 700 ml dilute milk (milk to water, 5:2) for 10 min. The product had acceptable flavour, but the texture was found to be depending on the initial soaking of the beaten rice. While traditional frying of the flakes gave a hard texture to the flakes, prolonged soaking in milk gave a pasty mass. Addition of a small quantity of ghee to the soaked beaten rice improved the texture of the payasam. However, the flakes were found to be hard. Therefore, attempts were made to get a product with a better texture. Dry Avalakki flakes fried in ghee were cooked during concentration of milk with sugar. This was followed of crystallization drying technique as followed in the preparation of dry mix for palada payasam (Anonymous, 2004).

Reconstitution: About 200 g of the dry mix was boiled with occasional stirring for 2 -3 min in 500 ml of milk. The payasam thus prepared compared well in consistency and other organoleptic properties with traditional made payasam. The shelf-life studies of the dry mix are in progress.
5.3 Gasa Gase Payasam Dry Mix

Surendra Nath et al. (2000) developed a process for production of dry mix of gasa gase payasam, which has been commercialised. The process involved soaking of powdered gasa gase and rice in water, mixing both of these ingredients along with coconut powder and grinding into a fine paste. The paste along with milk and sugar were concentrated in a stainless steel jacketed steam kettle and crystallised out as dry mix. As desired, cardamom flavour could be incorporated into the product at this stage. This product packed in polyethylene pouches kept well for more than 3 months at ambient temperature. The proximate composition of the mix was: moisture 4 %, fat 15%, protein 13%, lactose 4%, sucrose 56% and starch 6%. Three hundred g of the mix gave about one litre of gasa gase payasam when reconstituted with 1 litre of dilute milk (1:1) and boiled for 2 -3 min. This payasam compared well with the traditionally prepared product.

Another formulation reported by Rao, et. al, (2003) involved roasting of rice (25 g), gasa gase (50 g), and grated copra (25 g) followed by dry grinding. The powdered ingredients are dry mixed with whole milk powder (40 g) and powdered sugar (200 g). The powdered sugar contained 12.5% of it in caramelised form. Payasam can be prepared from the dry mix by mixing 150 g of the mix in 250 ml toned milk diluted with equal quantity of water. The mixture was pressure cooked for a few seconds at 15 psi in a pressure cooker, and the cooked contents were then mixed for a few seconds in a home mixer for texture development. The formulated mix has average moisture content of 3.93 % and water activity 0.636 (Rao, et. al, 2003).

6.0 Conclusion

India, being a land of rich cultures, has a tradition of eating and offering sweets on auspicious moments. Milk sweets are the main items for this purpose. The growing demand of ethnic foods in both domestic and export markets have necessitated the need for application of various preservation techniques for the long term storage of these products which otherwise have poor shelf life. Retort processing and fermentation, the well-known methods of preserving food products have been successfully applied to extend the shelf life of certain traditional milk products and desserts.

7.0 Suggested Readings


1.0 Introduction

The pressure driven membrane processes are based on the ability of semi-permeable membranes of appropriate physical and chemical nature to discriminate between molecules-primarily on the basis of size and to a lesser extent on shape and chemical composition. The main membrane systems in ascending order of pore size are: reverse osmosis (RO), nonofiltration (NF), ultrafiltration (UF) and microfiltration (MF). The distinction between RO, NF, UF and MF is somewhat arbitrary and has evolved with time and usage. In a broader sense, RO is essentially a dewatering technique, NF a demineralization process, UF a method for fractionation and MF a clarification process.

Membrane processes have many applications in the dairy industry and are increasingly being used because of several inherent advantages. Membrane processes can be carried out at ambient temperature. Thus, thermal degradation problems common to evaporation processes can be avoided resulting in better nutritional and functional properties of milk constituents. Further, these are continuous molecular separation processes that do not involve either a phase change or inter-phase mass transfer. Therefore, energy requirements of membranes processes are very low compared with other processes such as evaporation, freeze concentration, and freeze-drying. Further, easy, simple and economical operation, improved recovery of constituents and better yield of products are other advantages for which membrane processes are valued.

2.0 Application of Reverse Osmosis

RO is the most energy efficient dewatering process. Fluid milks and buttermilk can be partially concentrated economically using RO, particularly for the preparation of concentrated and dried products including indigenous dairy products like khoa, chakka, shrirhand, rabri, basundi and kheer. The economical levels of RO concentration for whole milk is up to 30% TS and for skim milk, 22% TS.

2.1 Khoa from RO Concentrates

Khoa, an important indigenous Indian milk product, is presently manufactured on a small scale by continuous boiling of whole milk until a desirable solids concentration (65-70% total solids) is obtained. In recent years, several attempts have been made to develop new methods including the use of scraped surface heat kettles or heat exchangers for commercial production of khoa. The use of concentrated milk having up to 30% TS has
produced khoa of highly satisfactory quality. The reverse osmosis, being energy effective process for pre-concentration of milk prior to the manufacture of khoa, has great potential in India. Khoa has been prepared from cow milk as well as buffalo milk by atmospheric boiling of RO retentates in a steam kettle (Gupta and Pal, 1994; Pal and Cheryan, 1987). The most important difference in control khoa and RO khoa was the higher moisture retention and lower free fat content in the later. Use of highly concentrated milk adversely affects the flavour quality. The process is conveniently amenable to continuous production of khoa from RO milk retentate using SSHE. Such process offers attractive energy saving in the initial concentration of milk. The energy consumption in RO concentration was estimated to about 80 kcal/kg of milk for batch process and 25 kcal for continuous process, which brings about a net saving of 335 to 430 kcal/kg of milk.

2.2 Chakka from RO Concentrates

Sachdeva et al., (1994), reported manufacture of ‘Chakka’ from milk concentrated by reverse osmosis (RO). Cow milk, standardised to fat : SNF ratio of 1 : 2.2 (12.5% TS), was pasteurised and concentrated (2.5 fold) using an RO plant. The concentrate was subjected to heat treatment of 90°C/5 min, cooled to 22°C, cultured at the rate of 2% with a mixed strain lactic culture and incubated for 18 hours. The coagulum thus obtained was filtered and a minimal amount of whey (4.5 lit/40 lit. of coagulum) having 18% TS was removed from it to get the chakka. Good quality shrikhand could be produced from RO chakka.

The RO chakka had 32.7% TS, fat 10.3%, 8.8% protein, 11.7% Lactose and 1.9% ash against the respective values for conventional chakka of 28.0%, 11.5%, 12.6%, 2.6% and 1.3%. The yield of RD Chakka was 35.5% as compared to 28.3% in case of conventional chakka. Increased yield, higher solids recovery, reduced processing time, increased throughput, access to mechanisation and alleviation of whey disposal problem are claimed as major advantages of this process.

3.0 Application of Nanofiltration

Pal et al. (2002) and Sudhir (2002) reported that the inherent problem of salty taste and sandy texture in khoa could be overcome by nanofiltration of cow milk to 1.5 fold concentration before khoa manufacture. Dahi prepared from nanofiltered cow milk was also found to be superior to that of normal cow milk dahi.

4.0 Application of Ultrafiltration

Ultrafiltration has a wide range of applications in the dairy industry. From milk, UF produces a permeate containing water, lactose, soluble minerals, non-protein nitrogen and water-soluble vitamins and a retentate in which proteins, fat and colloidal salts content increase in proportion to the amount of permeate removed. The process has also been used for the manufacture of several fermented dairy products like Yoghurt and Srikhand. UF retentate seems to be a highly promising base for chhana, rasogolla mix powder, long-life paneer. UF technology has also been applied to upgrade khoa manufacture from cow and buffalo milks.
4.1 Chhana

Preparation of good quality chhana using skim milk ultrafiltered-diafiltered retentate and plastic cream has been reported (Sharma and Reuter, 1991). Skim milk, heated to 95°C for 5 min., is ultrafiltered (26% TS). The retentate is diafiltered (23% TS) with equal amount of water to reduce lactose. For preparation of chhana, the retentate is mixed with plastic cream to a protein/fat ratio of 0.722. The mixture is heated to 85-90°C/5 min. and coagulated with dilute lactic acid to develop the characteristic grain. The granular mass is subsequently pressed to remove free moisture, yielding chhana. The process is reported to yield about 18-19 percent extra product and also no significant difference in flavour, body and texture and appearance compared to traditional method. High yield, easy automation and flexibility in operation are emphasized as advantages of this method for adoption for large-scale production.

Kumar et al. (2005) reported improved quality of UF chhana from cow milk. Cow skim milk was ultrafiltered and diafiltered to an optimum 23.88% TS. The required quantity of 63-65% fat fresh cream was then added to the UF retentate for standardization of fat. An innovative new approach i.e. addition of coagulant to UF retentate mixture at room temperature and then heating to coagulation temperature, optimum being 60°C, resulted in production of desired softer chhana with higher moisture content, suitable for making sweets (rasogolla and sandesh), along with higher yield (12.92%) and higher total solid recovery (10.89%) than in traditional chhana and lesser total solid losses in whey compared to when UF chhana was prepared using traditional approach. Slow stirring (60-80 rpm) during heating and coagulation of UF retentate mixture yielded lower moisture (54.53%) content in chhana, compared to 56.93% moisture with rapid stirring (130-150 rpm). Standardized UF chhana met PFA standards and was comparable to traditional chhana organoleptically. Rasogolla and sandesh, prepared with modified process from UF chhana, scored “liked moderately” to “liked very much” on sensory evaluation.

Kumar (2006) standardized the manufacturing process of good quality chhana from a mixture of buffalo milk and sweet cream buttermilk by employing UF process. The standardized process gave higher yield (13.03%) and higher total solid recovery (11.49%) in UF chhana compared to the traditional process. The standardized UF chhana had 57.6% moisture and scored 7.5 for body and texture on 9-point Hedonic scale. The manufacturing process of optimum quality rasogolla and sandesh produced from UF chhana were also standardized. UF rasogolla & sandesh scored 7.7 & 8.17, respectively, for overall sensory acceptability on 9-point Hedonic scale.

4.2 Rasogolla Mix Powder

Manufacture of rasogolla is probably most difficult amongst all the milk-based delicacies. It requires lot of art and experience in addition to the right type of raw materials. The use of ultrafiltration process has been made in our endeavour to produce base for the rasogolla mix powder (Pal et al., 1994). Cow skim milk is ultrafiltered to about 3-fold concentration to achieve a product containing all the milk proteins and part of the minerals and lactose. To reduce the mineral and lactose level to almost the same level as in chhana,
UF retentate has to be diafiltered. The pasteurised cream is added to diafiltered retentate followed by spray drying adopting standard conditions. The dried retentate is blended with selected additives to produce desired flavour and texture. The dried rasogolla mix has about 5 months at 30°C. Production of rasogolla mix powder offers following benefits:

- Offers economic use of seasonal and regional milk surpluses.
- Produce sweets of consistent quality at the convenience of users.
- Adaptable to medium and industrial scale dairy processing operations.
- Allows product diversification with manageable investments for improved productivity of the dairy industry.
- The products offer good export potential.

4.2.1 Rasogolla Making from Dried Mix

Equal quantities of water is added to the mix powder and kept for about 5 min for rehydration of proteins. Circular balls of about 7g size are rolled out in a manner that no cracks appear on the surface. Balls are cooked in the boiling sugar syrup, (maintained at 60% consistency) for 15 min with plenty of foam around the balls. The cooked balls are transferred into another hot sugar syrup of about 40% consistency. The yield is almost 20% higher than that obtained by traditional method.

4.3 Paneer

Production of good quality paneer using ultrafiltration (UF) has been reported by Sachdeva et al. (1993). The process offers advantages like access to mechanisation, uniform quality, improved shelf life, increased yield and nutritionally better product. The method involves standardisation and heating of milk followed by UF, whereby lactose, water and some minerals are removed. The concentrated mass, which has about 40 percent total solids, is cold acidified to get the desired pH. Till this point, the product is flowable and can be easily dispensed into containers with automatic dispensing machines. The filled containers are then subjected to texturisation by microwave heating. The resulting product has typical characteristics of normal paneer. The yield increases by about 25 percent due to the retention of good quality whey proteins and the slightly increased moisture content.

In another approach, a fully sterilization process has been developed which yields a long shelf life paneer like product (Rao, 1991). Standardized buffalo milk is concentrated partly by vacuum concentration process and partly by employing UF to a level of total solids desired in the final product. After packing in metallised polyester pouches, product is formed by a texturising process at 115°C, which permits concomitant sterilization. The process permits greater product yield due to retention of whey solids, being 35 per cent as compared to 15 per cent obtained by conventional batch process.
Table 1: Compositional comparison between various types of paneers made by the traditional processes and Long life paneer made by the texturizing process.

<table>
<thead>
<tr>
<th>Chemical attribute</th>
<th>Traditional paneers</th>
<th>Concentrated milk paneer</th>
<th>UF paneer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full fat (5.8%)</td>
<td>Low fat (1.5%)</td>
<td>Skim milk (0.05%)</td>
</tr>
<tr>
<td>Fat</td>
<td>23.41 (50.84)</td>
<td>8.60 (22.47)</td>
<td>0.20 (0.56)</td>
</tr>
<tr>
<td>Protein</td>
<td>18.33 (39.81)</td>
<td>21.56 (56.32)</td>
<td>25.83 (72.92)</td>
</tr>
<tr>
<td>Lactose</td>
<td>2.40 (5.22)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Ash</td>
<td>1.90 (4.13)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Total Solids</td>
<td>46.04</td>
<td>38.28</td>
<td>35.42</td>
</tr>
<tr>
<td>Yield</td>
<td>20.00</td>
<td>16.30</td>
<td>14.10</td>
</tr>
</tbody>
</table>

Figures in parentheses indicate the values on moisture free basis

4.4 Shrikhand

The traditional technology allows the whey proteins to drain along with whey during the process of chakka making. These proteins, having high biological value could be recovered in chakka by the application of ultrafiltration to make, so called UF-chakka (Sharma and Reuter, 1992). Chakka and Shrikhand of good sensory quality and meeting PFA standards could be successfully prepared using ultrafiltration technology (Shukla, 2004). In standardized ultrafiltration process, skim milk coagulum obtained by fermentation of skim milk with yoghurt culture was heated to 60°C for 5 minute with continuous agitation and ultrafiltered up to around 16.60% TS concentration. Whey was then removed from this concentrated coagulum by hanging it in a muslin cloth (eight layered) at room temperature followed by mild pressing to get chakka. Chakka was then kneaded in a planetary mixer with 70% fat cream and sugar to prepare Shrikhand of smooth consistency. UF process resulted in nil fat loss in whey and 20.70% extra recovery of total solids in chakka. The protein content in skim milk chakka through UF process and in shrikhand prepared from it was higher than in traditional process.

4.5 Khoa

Khoa from cow milk has been reported to be salty in taste, sticky/pasty in body and texture and slight yellowish in colour. WPC addition has shown to improve the flavour, body and texture, colour and appearance and thereby overall sensory attributes of cow milk khoa. Addition of 5% WPC solids to cow milk improved the flavour, body and texture and colour of khoa prepared (Patel et al., 1993). WPC incorporated cow milk khoa compared well with the traditional buffalo milk khoa.

Though the flavour score for 12% WPC added khoa were higher than other WPC added khoa samples, the improvement was not statistically significant between 8%, 10% and
12% WPC added khoa (Sudhir, 2002). Increased level of WPC increased the grain size of khoa and decreased stickiness/pastiness, however, it also resulted in reduced cohesiveness and increased dryness in the product. Hence, the selection of level of WPC is subject to the requirement of type of khoa intended for further use e.g. Khoa prepared by addition of higher level can be suitable for kalakand like product.

Sudhir (2002) reported that the khoa with added WPC (80) from nanofiltered cow milk scored higher for flavour and overall scores (47 and 91.29, respectively) than khoa from nanofiltered cow milk (45.71 and 90.43, respectively). A definite increase in grain size for WPC added khoa from nanofiltered cow milk was observed. Khoa with added 12% WPC from nanofiltered cow milk scored more in flavour, body and texture (30.86), colour and appearance (13.42) and overall sensory scores than 12% WPC added khoa from cow milk (44.57, 30.36, 12.71 and 87.64, respectively). The scores of khoa from nanofiltered cow milk with added WPC were also comparable to commercial buffalo milk khoa, which scored 47.07, 31.5, 13.79 and 92.35 for flavour, body and texture and colour and appearance, respectively. However, the product obtained from use of nanofiltered cow milk tended to be sticky, which could be because of homogenization effect on cow milk. Nanofiltration of skimmed cow milk followed by standardization to fat : TS ratio of 0.38-0.4 and subsequent khoa making by WPC addition might probably obliterate this problem.

Reuter et al. (1990) incorporated 10 and 18% WPC (27.41% TS) solids in buffalo milk for the manufacture of khoa, Greater amount of WPC produced bigger grains in khoa, which is a desirable property for preparing Kalakand - a popular khoa based Indian sweet.

5.0 Suggested Readings


1.0 Introduction

In recent years, there has been a vast and rapidly growing body of scientific data showing that diet plays an important part in diseases. Diet is thought to contribute to six of the 10 leading causes of death. Nutrients and nonnutritive food components have been associated with the prevention and/or treatment of chronic diseases such as cancer, coronary heart disease, diabetes, hypertension, and osteoporosis. Up to 70% of certain cancers may be attributed to diet. As the data supporting the role of diet in health promotion and disease prevention continue to mount, it is likely that the quantity of enhanced foods will expand substantially. There is an increasing demand by consumers for quality of life, which is fueling the functional foods revolution. Functional foods are viewed as one option available for seeking cost-effective health care and improved health status. Moreover, the large baby-boomer segment of the population is aging and considerable health care budget in most country is focused on treatment rather than prevention. Thus, the use of nutraceuticals in daily diets can be seen as means to reduce escalating health care costs that will contribute not only to a longer lifespan, but also more importantly, to a longer health span. Development of functional food products will continue to grow throughout the 21st century as consumer demand for healthful products grows.

The exploding area of functional foods and probiotics shows considerable promise to expand the industry into new arenas. Both convenience and better for you attitudes are selling. Consumers clearly believe in the concept of functional nutrition, or specific association between foods/nutrients and health functions. They are interested in foods that boost the immune system, reduce the risk of disease and enhance health, which consumers self-prescribe for themselves and their families. Hence, there are clear opportunities to offer consumers dietary alternatives to medical solutions. These opportunities, however, will be highly consumer driven and success will ultimately be dependent upon defining your segment and knowing your target group.

The markets of traditional dairy products are increasingly getting overcrowded and our future success will depend on our ability to provide innovative products, which consumers want and need. Whatever the innovation - products, processing method or packaging - it should meet the real consumer need. We know today’s families want “grab-and-go” convenience. They are also concerned about nutrition and health. Different ages and demographics want different things. Therefore, investment at this level is essential if we are to respond rapidly to customers who are increasingly demanding new and different taste experiences from products that are also competitively priced. Thanks to advancements in
technology, researchers have shown that specific components of milk, as well as ingredients can be readily added to dairy products, which contribute to health and wellness, and assist consumers with feeling balanced and satisfied. There is a golden opportunity for dairy marketers to formulate innovative products to meet consumers' needs and to effectively market the product's value. New variants of sweets can be developed. Indigenous dairy products containing health-promoting ingredients may be developed and promoted. Host of ingredients with health benefits are available for value addition of traditional dairy products. Some of these issues are discussed hereunder.

2.0  Functional Ingredients for Value Addition

Functional nutrition is a broad topic, and covers many ingredient categories. The functional components used in formulation of these formulated foods are given in Table 1.

<table>
<thead>
<tr>
<th>Class/ Ingredients</th>
<th>Source*</th>
<th>Potential Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotenoids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta-carotene</td>
<td>carrots, various fruits</td>
<td>neutralizes free radicals which may damage cells; bolsters cellular antioxidant defenses</td>
</tr>
<tr>
<td>Lutein, Zeaxanthin</td>
<td>kale, collards, spinach, corn, eggs, citrus</td>
<td>may contribute to maintenance of healthy vision</td>
</tr>
<tr>
<td>Lycopene</td>
<td>tomatoes and processed tomato products</td>
<td>may contribute to maintenance of prostate health</td>
</tr>
<tr>
<td>Dietary (functional and total) Fiber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insoluble fiber</td>
<td>wheat bran</td>
<td>may contribute to maintenance of a healthy digestive tract</td>
</tr>
<tr>
<td>Beta glucan</td>
<td>oat bran, rolled oats, oat flour</td>
<td>may reduce risk of coronary heart disease (CHD)</td>
</tr>
<tr>
<td>Soluble fiber</td>
<td>psyllium seed husk</td>
<td>may reduce risk of CHD</td>
</tr>
<tr>
<td>Whole grains</td>
<td>cereal grains</td>
<td>may reduce risk of CHD and cancer; may contribute to maintenance of healthy blood glucose levels</td>
</tr>
<tr>
<td>Fatty Acids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monounsaturated fatty acids (MUFAs)</td>
<td>tree nuts</td>
<td>may reduce risk of CHD</td>
</tr>
<tr>
<td>Polyunsaturated fatty acids (PUFAs) - Omega-3 fatty acids—ALA</td>
<td>walnuts, flax</td>
<td>may contribute to maintenance of mental and visual function</td>
</tr>
<tr>
<td>PUFAs - Omega-3 fatty acids—DHA/EPA</td>
<td>salmon, tuna, marine and other fish oils</td>
<td>may reduce risk of CHD; may contribute to maintenance of mental and visual function</td>
</tr>
<tr>
<td>PUFAs - Conjugated linoleic acid (CLA)</td>
<td>beef and lamb; some cheese</td>
<td>may contribute to maintenance of desirable body composition and healthy immune function</td>
</tr>
<tr>
<td>Flavonoids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anthocyanidins</td>
<td>berries, cherries, red grapes</td>
<td>bolster cellular antioxidant defenses; may contribute to maintenance of brain function</td>
</tr>
<tr>
<td>Flavanols—Catechins, Epicatechins, Procyanidins</td>
<td>tea, cocoa, chocolate, apples, grapes</td>
<td>may contribute to maintenance of heart health</td>
</tr>
<tr>
<td>Flavanones</td>
<td>citrus foods</td>
<td>neutralize free radicals which may damage cells; bolster cellular antioxidant defenses</td>
</tr>
<tr>
<td><strong>Flavonols</strong></td>
<td>onions, apples, tea, broccoli</td>
<td>neutralize free radicals which may damage cells; bolster cellular antioxidant defenses</td>
</tr>
<tr>
<td><strong>Proanthocyanidins</strong></td>
<td>cranberries, cocoa, apples, strawberries, grapes, wine, peanuts, cinnamon</td>
<td>may contribute to maintenance of urinary tract health and heart health</td>
</tr>
<tr>
<td><strong>Isothiocyanates</strong></td>
<td>cauliflower, broccoli, broccoli sprouts, cabbage, kale, horseradish</td>
<td>may enhance detoxification of undesirable compounds and bolster cellular antioxidant defenses</td>
</tr>
<tr>
<td><strong>Sulforaphane</strong></td>
<td>cabbage, broccoli, and horseradish</td>
<td>may enhance detoxification of undesirable compounds and bolster cellular antioxidant defenses</td>
</tr>
<tr>
<td><strong>Phenols</strong></td>
<td>apples, pears, citrus fruits, some vegetables</td>
<td>may bolster cellular antioxidant defenses; may contribute to maintenance of healthy vision and heart health</td>
</tr>
<tr>
<td><strong>Plant Stanols/Sterols</strong></td>
<td>corn, soy, wheat, wood oils, fortified foods and beverages</td>
<td>may reduce risk of CHD</td>
</tr>
<tr>
<td><strong>Free Stanols/Sterols</strong></td>
<td>fortified table spreads, stanol ester dietary supplements</td>
<td>may reduce risk of CHD</td>
</tr>
<tr>
<td><strong>Polyols</strong></td>
<td>some chewing gums and other food applications</td>
<td>may reduce risk of dental caries</td>
</tr>
<tr>
<td><strong>Prebiotic/Probiotics</strong></td>
<td>whole grains, onions, some fruits, garlic, honey, leeks, fortified foods and beverages</td>
<td>may improve gastrointestinal health; may improve calcium absorption</td>
</tr>
<tr>
<td><strong>Inulin, Fructo-oligosaccharides (FOS), Polydextrose</strong></td>
<td>yogurt, other dairy and non-dairy applications</td>
<td>may improve gastrointestinal health and systemic immunity</td>
</tr>
<tr>
<td><strong>Lactobacilli, Bifidobacteria</strong></td>
<td>soybeans and soy-based foods</td>
<td>may contribute to maintenance of bone health, healthy brain and immune function; for women, maintenance of menopausal health</td>
</tr>
<tr>
<td><strong>Isoflavones—Daidzein, Genistein</strong></td>
<td>flax, rye, some vegetables</td>
<td>may contribute to maintenance of heart health and healthy immune function</td>
</tr>
<tr>
<td><strong>Lignans</strong></td>
<td>garlic, onions, leeks, scallions</td>
<td>may contribute to maintenance of heart health and healthy immune function</td>
</tr>
<tr>
<td><strong>Soy Protein</strong></td>
<td>cruciferous vegetables</td>
<td>contribute to maintenance of healthy immune function</td>
</tr>
<tr>
<td><strong>Sulfides/Thiols</strong></td>
<td></td>
<td>may enhance detoxification of undesirable compounds; may contribute to maintenance of heart health and healthy immune function</td>
</tr>
</tbody>
</table>

Examples are not an all-inclusive list.

Several functional traditional dairy products can be developed using either single or combination of ingredients given in the table targeting specific health benefits. Besides these functional ingredients, which are mostly obtained from plant source, there are other ingredients such as fat replacers, artificial sweeteners, micronutrients like vitamins and minerals, which can be used for value addition.
3.0 What are the possibilities?

3.1 Probiotic Traditional Dairy Products

“Probiotic, food products in generals and "probiotic" organism in particular are in the center of current R & D activities all over the world. “Functional foods” segment that is registering a steady and consistent growth at present, among processed food products, gathered the momentum primarily from the scientific investigations based on “probiotic” food products. A probiotic is a mono-or mixed culture of live microorganisms which benefits man or animals by improving the properties of the indigenous microflora. Viable counts delivered to the gastrointestinal tract are key to the functionality of probiotics. The consumption of probiotic culture positively affect the composition of this micro-flora or extends a range of host benefits including.

1. Pathogen interference, exclusion and antagonism.
2. Immunostimulation and immunomodulation.
3. Anticarcinogenic or antimutagenic activities.
4. Alleviation of symptoms of lactose intolerance.
5. Reduction in serum cholesterol.
6. Reduction in blood pressures.
7. Decreased incidence & duration of diarrhoea.

Industrial interest in developing probiotics and probiotic functional foods is thriving, driven largely by the market potential for foods that target general health or well being. NDRI has made some progress in this area by developing probiotic dahi, lassi and probiotic cheese. There is possibility of developing other milk based fermented traditional dairy products such as probiotic shrikand and Rabadi – a milk-cereal based fermented product.

3.2 Fat-Replacement in Indigenous Dairy Products

High fat consumption has been linked to several chronic diseases including cardiovascular diseases, obesity and certain forms of cancer. Nutrition experts recommend a total fat intake of less than 30 per cent of total daily calories. These dietary recommendations are one reason for the increasing demand for lower fat food products of the world market has been flooded with the food products carrying the labels "low fat", 'no fat' or 'reduced fat'. Fat mimics or fat substitutes are normally used to produce low-fat foods, fat mimics are substances that help replace the mouthfeel of fat but can not substitute for fat on a gram for gram basis and can not be used for applications involving frying. Substances whose physical or thermal properties resemble fat are termed as fat substitutes and can replace fat on a gram-for gram basis and can also be used for frying applications.

Low-fat cheese, processed cheese, cultured products, frozen desserts, butters and spreads have been successfully developed using commercially available fat mimics/replacers. Using similar technique several low fat varieties of traditional dairy products can be developed. An attempt has been made to develop low fat burfi at this institute.
### Categories of fat replacers

<table>
<thead>
<tr>
<th>Protein based</th>
<th>Carbohydrate based</th>
<th>Fat replacers</th>
</tr>
</thead>
<tbody>
<tr>
<td>- whey protein conc.</td>
<td>- Starches</td>
<td>- Emulsifiers</td>
</tr>
<tr>
<td>- Microparticulated protein</td>
<td>- Maltodextrins</td>
<td>- Medium chain triacylglycerols.</td>
</tr>
<tr>
<td></td>
<td>- Polydextrose</td>
<td>- Structural lipids.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>- Acaloric synthetic compounds.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>* fatty alcohol esters of alkyl malonic or malonic acid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* esterified propoxylated glycerols</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* trialkoxy tricarballylate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* poly carboxylic acid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Sucrose polyesters</td>
</tr>
</tbody>
</table>

### 3.3 TDP for Providing Satiety

There are a few dairy products currently in the marketplace, which claim to provide satiety. This is an opportunity dairy product manufacturers need to tap into, too. Satiety is the state of being full or gratified to the point of satisfaction. Scientific studies indicate that satiety is dependant on not only how much food you eat, but what type of food you eat as well. Satiety is being addressed on food labels with synonymous terms such as “hearty” and “controls or reduces hunger.” Unabsorbed nutrients in the ileum, which is the final section of the small intestine, inhibit gastric emptying, providing a sense of satiety. Fat, in particular, penetrates the ileum when a person has eaten too much for the body to process. When this happens the ileum triggers a “full” message to the brain. That full message is the result of the secretion of cholecystokinin (CCK), a peptide hormone of the gastrointestinal system responsible for stimulating the digestion of fat and protein. It is secreted by the duodenum, the first segment of the small intestine, and causes the release of digestive enzymes and bile from the pancreas and gall bladder, respectively.

A satiety ingredient concept is available to dairy foods manufacturers. A patented combination of oat and palm oils has been formulated into a novel emulsion with the oat oil extract containing a large quantity of polar lipids that coat the palm oil droplets. This coating prevents digestion of the palm oil in the stomach until it reaches the ileum. Fiber ingredient suppliers, too, are touting some of their products for satiety value. For example, research shows consumers on diets supplemented with inulin and oligofructose report higher levels of satiety, longer feelings of fullness and lower calorie intake, which can all assist with weight loss. Research also shows that foods high in fiber and protein slow digestion and extend the release of CCK.

With knowledge of this relationship between fiber, protein and satiety, several convenient, nutritious and delicious indigenous products can be created for obese people, which can help them feel full and thus prevent unhealthful snacking between meals.
3.4 A Heart-Healthy Opportunity

With the functional food market abuzz about the heart-health benefits of plant sterols, dairy foods formulators have excellent opportunity to develop variety of TDP with heart healthy benefit. Plant sterols can help lower serum low-density lipoprotein (LDL)—or bad—cholesterol levels, which are well recognized as impacting heart disease risk. Eating foods low in saturated fat and cholesterol and high in sterols can reduce LDL cholesterol by 20%. Plant sterols provide an effective, dietary method for countering elevated cholesterol, a crisis facing millions of Indians.

Plant sterols are relatively easy to formulate into existing dairy applications, and sterols are available in different forms to aid in the ease of processing. Likewise, plant sterols can be used in virtually any dairy application. If included in the amounts specified for health claim, plant sterols also enhance a finished dairy product’s nutritional profile without altering its flavor or texture. The qualified claim states that foods containing at least 0.4g per serving of plant sterols, eaten twice a day with meals for a daily total intake of at least 0.8g, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease.

**Arjuna Ghee:** Arjuna ghee, with functionalities like resistance against heart diseases and blood pressure regulating properties was developed at this institute. The developed ghee was found sensorily similar to the market ghee. It had overall acceptability score of 85.1 compared to the control (90.84). The Arjuna ghee was found to be 4 times more stable to oxidative deterioration as compared to control ghee. This is due to the fact that Arjuna extract contains several antioxidants like polyphenols, terpenoids in addition to phytosterol, which are beneficial in case of Cardio-vascular Diseases (CVD), high blood pressure and to boost up our immune system.

3.5 Dietetic Indigenous Dairy Products

The dairy industry has responded to the growing needs of health conscious consumers for low-calorie foods. Consequently, a large number of dairy products made with low-calorie and nonnutritive sweeteners have been witnessed in the market. Low calorie sweeteners have become sugar alternatives to replace sucrose in a wide variety of dairy products. Kumar (2000) developed a low calorie lassi by using aspartame and reported that aspartame at a level of 0.08 % was required to replace 15 % of cane sugar in lassi.

The technology for the production of rasogolla, the most popular channa based Indian sweetmeat, was developed by Jayaprakash (2003) using sorbitol (40 %) and aspartame (0.08 %). Chetana, et al. (2004) developed gulabjamun, a popular khoa based sweet, using sorbitol. Burfi, another khoa based sweet delicacy was developed by completely replacing sugar using acesulfame-K (Yarrakula, 2006), aspartame (Muralidhar, 2006), saccharin (Narendra, 2006), sucralose (Singh, 2006), and sucralose and bulking agents (Prabha, 2006). Kalakand and flavored milk were developed using acesulfame-K (Yarrakula, 2006), aspartame (Muralidhar, 2006), saccharin (Narendra, 2006), and sucralose (Singh, 2006). The Indian counterpart for ice cream, kulfi was developed by Pandit (2004) using sorbitol (5.5 %), maltodextrin (4.26 %) and aspartame (742 ppm).
3.6 Indigenous Dairy Products Fortified with Dietary Fiber

Milk and most dairy products are devoid of dietary fiber. With the growing interest in dietary fiber and its health benefits, dairy industry has geared up for fortifying the dairy products with fiber.

Yogurt is one of the dairy products whose sales continues to increase due to diversification in the range of yogurt-like products including reduced fat content yogurts, yogurt shakes, drinkable yogurts, yogurt mousse, yogurt ice cream, etc. (Fiszman and Salvador, 1999).

In India, there are few traditional dairy products that contain significant quantities of fiber e.g., Gajar-pak (carrot halwa), Giya-ka-halwa (bottle gourd halwa), Doda-burfi, and Kaju-burfi. Traditionally made cereals-based milk desserts like kheer and dalia-dessert are other dairy food sources of dietary fiber in Indian diets (Patel and Arora, 2005). Recently, dahi (Chandrakant, 2002), lassi and other dairy products have been fortified with fruits and commercial dietary fibers to give the benefits of dietary fiber. Kantha (2005) developed a low fat paneer using soy fiber and inulin and reported that milk with 2.5 % fat and 0.56 % soy fiber or 1.8 % fat and 4.5 % inulin yielded a paneer similar to that prepared from full cream milk (6 % fat) in respect to sensory quality. Amul has launched a new variety of isabgol-enriched ice cream. Isabgol is the seed derived from Plantago ovata. Being a 'true dietary fibre', the isabgol husk is considered to be a natural laxative that aids easy bowel movement. Besides it is also known to possess serum cholesterol reducing properties (Mann and Singh, 2005).

4.0 Targeting a Successful Product Launch

In order to launch the product successfully in the market it is necessary to look in to following points:

- Identifying where the gaps are in a specific market--what the new/unmet consumer needs are.
- Developing product concepts and consumer value propositions to fill the gaps.
- Proper ingredient selection, formulating prototypes and evaluating product concepts at an in-house pilot plant.

Fundamentally the product needs to pass the taste test. If it does not taste good, it is not possible to get that repeat buy from consumer. Any product that has been developed by hitting a bull's eye in each one of these areas (health and wellness, simplicity and taste) will certainly have a stronger chance for a successful product launch.

5.0 What are the Prospects for Functional Foods in India?

Population growth, rising incomes, increasing awareness on health, urbanization, lifestyle changes ("on-the-go" eating) and growing organized retailing are contributing to the potential for functional foods. Just as for processed foods in general, India will be the largest potential markets for functional foods with their GDP growth, demographics and burgeoning consumption.
Thanks to the growing acceptance of functional foods, India could hope to leverage the country's key resources in this area to gain a foothold in the global market. Functional foods are among the New Age drugs that are being developed to provide better health. Functional foods are gaining public acceptance in many developed countries in recent times. Looking at the changing trends, the market of functional foods has huge potential. These days, industries are showing interest in the functional foods area. Within few years this potential can turn into a healthy growing market.

The ingredients used in health/functional foods are mainly plant-based products and most of them being predominantly herbal. Hence clues to these functional ingredients could be got from our ancient and traditional systems of medicine like Ayurveda, Siddha and Unani. The 'Rasayan' and 'Vajikarna' therapeutics of Ayurveda are essentially nutraceuticals and therefore there is ample scope for India to develop a range of health food products. And to succeed, these products have to be standardized and with scientific validation to ensure safety and efficacy so as to instill confidence in the customers to use them not as an alternative medicine but as a well defined system of medicine. For this to happen, there has to be research carried out on these products. Thus India's own traditional knowledge base gathered from Unani, Ayurveda and Siddha can help out in research work on nutraceuticals. And we can take a lead on this from the western world.

6.0 What are the Key Challenges for Functional Foods in India?

In India, we have traditional products touted as functional but have little scientific validation. Regulations will thus have to evolve to weigh R&D, ensure validation and prevent exploitation of consumers. Companies will also have to be sincere and honest in their claims while marketing and communicating with consumers till appropriate regulations for scientific validation are evolved. Processors will need to provide an optimal merger between taste, convenience and health attributes.

7.0 Suggested Readings


1.0 Introduction

Since early ages the incessant search for health has guided mankind to bring about changes in the eating habits and life style. In the last couple of decades the growing concern about health has encouraged people to reduce the consumption of food rich in sugar and fat. The discovery of several ingredients used for sugar and fat substitution during the last decade has triggered the development of new sugar free and or low fat products. The dietary options that such products provide may be especially helpful in management of ailments like obesity and diabetes mellitus, which have become an epidemic worldwide. According to a recent report of World Health Organization (Savitha, 2006), India now has the dubious distinction of being the diabetic capital of the world with over 32 million people affected by it, whereas the figure is close to 171 million for rest of the world and expected to touch 366 million by 2030. This statistics indicate the graveness of the situation and need attention.

Sugar and fat are the important constituents of enumerable traditional dairy products including khoa and chhana based sweets and various frozen dairy desserts namely burfi, gulabjamun, sandesh, peda, kalakand, rasoogulla, kulfí etc. The very high content of fat and sugar in these delicacies makes them unsuitable for the dietary regime of the obese and diabetic people. Hence the low fat and low sugar counterparts of the traditional foods are in vogue. Efforts have been made in recent past to develop technologies for such products as delineated in the foregoing section.

2.0 Technological considerations for development of low fat and sugar free products

Despite of the availability of variety of alternative sweeteners and fat replacers with improved safety, stability and functionality in the food ingredient market, developing such products is not an easy task. Reformulation should not significantly affect the rheological and sensory characteristics, comply with the existing processing conditions and conform to legal requirements. It is very difficult to deliver all the functionality of the sugar as well as fat in the product particularly in following cases

- when sugar and fat constitute a large proportion of the original formulation, and
- when processing conditions require more sever heat treatment for example in heat desiccated dairy products.

However, in products which require relatively low heat processing conditions and low temperature storage conditions, the replacement of sugar in particular is comparatively easier.
3.0 Fat substitution

The fat in a food system delivers very complex mixture of attributes in terms of appearance, texture, flavour, mouthfeel, and processing characteristics. Fat replacement in any formulation requires attention to ingredients other than fat. Formulator needs to consider adjustment of all ingredients other than fat in the formulation to address mouthfeel, texture, colour, flavour and stability. The term “Fat replacer” is a generic term for any bulking agent or ingredient that somehow replaces fat in a system (Deis, 2001). Fat replacers can be placed in to two general classes, modified fats and water binders. Modified fats or fat substitutes like olestra, salatrim, caprenin, sorbestrin, are compounds physically and chemically similar to fats and replace triglycerides in foods. Fat mimetics or water binders are either protein or carbohydrates that have been physically or chemically processed to mimic the functions of fats in foods by virtue of their property to bind large quantities of water and small particles which are perceived as fat on the tongue. Simplesse, Trailblazer, Lita, Miprodan, and Nutrifat are important among protein based fat replacers. Their use has been reported in frozen desserts, sour cream, yoghurt, butter spreads, cheese spreads, cheeses and ice-cream. Simplesse® is a low calorie protein based fat substitute confirmed as GRAS, produced from milk and / or egg proteins via micro particulation process and its one gram can replace one gram of fat. Trailblazer® as said to be a similar fat replacer but made with a different process. DairyLo® is another milk protein based fat replacer (WP) made by denaturation of ultra filtered whey proteins by controlled heat treatment. It can be used in dairy products (2-5%) to contribute desirable mouthfeel attributes.

4.0 Sugar substitution

Alternative sweeteners which can be used to replace sugars fall into two basic categories:

– those which are calorie free (often referred to as high intensity, intense, high potency, artificial or non-nutritive sweeteners), and

– those which are significantly reduced in calorie or bulk sweeteners. Intense sweeteners are those substances, which on weight basis are substantially sweeter than the common carbohydrate sweeteners such as sucrose

Intense sweeteners are constituted of compounds that mimic the effects of sugars on the tongue and pass the human intestine unmetabolised without producing any calories. The properties of most commonly used high potency sweeteners are presented in Table 2. High potency sweeteners alone cannot provide bulk and other functional characteristics of sugar, so a combination approach is always adopted and bulking agents are used for this purpose. But, bulking agents are not needed in case of formulations where sugar is used at low levels and it does not contribute much for the body and texture of the product. Increasing the proportion of other component of the formulation can also serve the purpose, in such formulations. The bulking agents have fewer calories than sucrose, and possess physical properties similar to sugar. These substances attempt to deliver all functionality of sucrose (Pszczola, 2003). Analysis of the organoleptic or functional properties of each single sweetener clearly shows that none of the currently known sugar substitutes comes close to the taste and functional properties of sucrose (Bakal, 2001). Most exhibit one or more of these differences.
1. Taste properties, such as delayed sweetness perception, undesirable and lingering aftertaste, narrow taste profile, or bitterness. For example, saccharin is generally reported to have bitter aftertaste; steviosides have menthol-like aftertaste and aspartame has a delayed sweetness.

2. Lack of bulking properties.

3. Stability problems during processing and storage. For example, aspartame loses its sweetness in aqueous solutions and is not stable at high temperatures.

<table>
<thead>
<tr>
<th>Table 2: Properties of High Potency Sweeteners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properties</td>
</tr>
<tr>
<td>Molecular formula</td>
</tr>
<tr>
<td>Molecular wt</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Function</td>
</tr>
<tr>
<td>Sweetness potency vis-à-vis sucrose</td>
</tr>
<tr>
<td>Solubility</td>
</tr>
<tr>
<td>Calorie/g</td>
</tr>
<tr>
<td>ADI</td>
</tr>
<tr>
<td>Brand names</td>
</tr>
</tbody>
</table>

A variety of sugar alcohols (polyols) and other sweeteners can be used in foods to substitute for the bulk or volume of sugar and some of its sweetness. These ingredients usually replace sugar on a 1-to-1 basis. Because some polyols are not as sweet as sugar, a low-calorie sweetener may also be included in the product to provide additional sweetness. The most familiar polyols are sorbitol, mannitol, and xylitol. Other polyols permitted for use in food in the United States include isomalt, erythritol, lactitol, and maltitol. Hydrogenated starch hydrolysates and hydrogenated glucose syrups are also used for similar purposes. Polyols and similar sweeteners are classified as GRAS food ingredients in the United States and others are regulated as food additives. Polyols produce a lower glycemic response than most sugars and starches (ADA, 2004). Another potential advantage is that most polyols are lower in calories than sugar (Table 3). Most polyols are incompletely
digested and poorly absorbed thus have less caloric values than that of sugar. Incomplete absorption, however, may also have disadvantages (McNutt 2000). The gastrointestinal effects of foods containing polyols are similar to those associated with other foods containing carbohydrates of low digestibility, such as dried fruits or bran cereals. Some products containing sorbitol or mannitol carry a label statement indicating “excess consumption may have a laxative effect.” This statement is required by the USFDA if consumption of the product is likely to result in ingestion of 50 g or more per d of sorbitol or 20 g or more per day of mannitol. Other important bulking agents are converted starches, inulin, isomalt, raftilose and polydextrose.

Table 3: Calorific values of commercially common polyols

<table>
<thead>
<tr>
<th>Polyols</th>
<th>Calorific value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorbitol</td>
<td>2.6 Cal/g</td>
</tr>
<tr>
<td>Mannitol</td>
<td>1.6 Cal/g</td>
</tr>
<tr>
<td>Xylitol</td>
<td>2.4 Cal/g</td>
</tr>
<tr>
<td>Erythritol</td>
<td>0.2 Cal/g</td>
</tr>
<tr>
<td>Isomalt</td>
<td>2.0 Cal/g</td>
</tr>
<tr>
<td>Lactitol</td>
<td>2.0 Cal/g</td>
</tr>
<tr>
<td>Maltitol</td>
<td>2.1 Cal/g</td>
</tr>
<tr>
<td>Hydrogenated starch hydrolysate</td>
<td>3.0 Cal/g</td>
</tr>
</tbody>
</table>

( Source: McNutt 2000)

5.0 Regulatory status of high potency sweeteners in India

According to a notification amending the Prevention of Food Adulteration issued by the Ministry of Health and Family Welfare on June 25, 2004 the use of artificial sweeteners has been allowed in food items including milk sweets and desserts (Table. 4). The change in the food law opens up a vast untapped market of sugar-free food products including sugar-free confec tionery.

6.0 Multiple Ingredients Approach

The advantages of the multiple sweetener approach have long been recognized. A variety of approved sweeteners are essential because no sweetener is perfect for all uses. Limitations of individual sweeteners can be overcome by using them in blends. The two sweeteners when combined have a synergistic effect that is the sweetness of the combination is greater than the sum of individual parts. This is true for most sweetener blends. The polyols are also important adjuncts to sugar free product development. These sweeteners provide the bulk of sugar but are generally less sweet than sucrose. The polyols, which are reduced in calories, combine well with low calorie sweeteners, resulting in good tasting reduced calorie products that are similar to their sucrose sweetened counterparts.
Table 4: List of PFA approved artificial sweeteners along their permitted usage limit for sweets

<table>
<thead>
<tr>
<th>Name of artificial sweetener</th>
<th>Article of food</th>
<th>Maximum limit of artificial sweetener (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saccharin Sodium</td>
<td>Sweets (carbohydrate based and milk based) – *Halwa, Mysore Pak, Boondi Ladoo, Jalebi, Khoya, Burfi, Peda, Gulabjamun, Rasogulla and similar milk product based sweets sold by any name.</td>
<td>500 ppm</td>
</tr>
<tr>
<td>Aspartame (methyl ester)</td>
<td></td>
<td>200 ppm</td>
</tr>
<tr>
<td>Acesulfame potassium</td>
<td></td>
<td>500 ppm</td>
</tr>
<tr>
<td>Sucralose</td>
<td></td>
<td>750 ppm</td>
</tr>
</tbody>
</table>

With the availability of fat replacers and low calorie bulking agents not just a multiple sweetener approach but a multiple ingredient approach to calorie control is being adopted. Replacing the fat and the sugar is therefore important in development of products to assist in calorie control.

7.0 Burfi

*Burfi*, the most popular *khoa* based confection among traditional dairy products, has its own distinguished niche in Indian diets during festive season as well as day-to-day life. Since it contains high amounts of fat and sugar, average values being 19.52% and 29.4% respectively, the obese and diabetic people cannot relish the taste of this delicacy.

The study has been done made aiming at developing technology for production of dietetic *burfi* for a target group of obese, diabetic and those prone to heart related problems (Prabha, 2006).

Studies were conducted for screening of the suitable fat replacers and bulking agents. The necessary modifications in the process compatible to the use of these fat replacers and sugar replacers were made. The critical compositional variables of dietetic *burfi* including levels of milk fat, fat replacers and bulking agents were optimized using RSM. Different high potency sweeteners viz. sucralose, aspartame, neotame, acesulfame-k and saccharin were assessed for their stability. Aspartame and neotame showed poor stability in dietetic *burfi*. Sucralose was selected as a high potency sweetener on the basis of its most preferred sweetness profile and excellent stability in the product. Shelf life studies revealed that vacuum packaged dietetic *burfi* can be stored without spoilage for 12 days at 30°C and 40 days at 5°C.
8.0 Rasogolla

*Rasogolla* is the most popular *chhana* based Indian sweetmeat. Because of its pleasant and delightful taste, the fame of this sweet has not only spread throughout India but is becoming popular abroad as well. Quite a considerable quantity of this sweet is now being exported to Middle East and European countries from Bikaner and West Bengal. Because of its high sugar content (32-55%) the people who are suffering from diabetes are not able to enjoy the delicious sweet. Technology has been developed for the manufacture of sugar free rasogolla using artificial sweeteners for such a large group of people. The levels of aspartame and sorbitol were optimized on the basis of sensory quality of the product using D6 Hokes design (RSM). The use of 40% sorbitol and 0.08% aspartame was found to be optimum for cooking of rasogulla balls. The higher sorbitol level resulted in hard body and unacceptable flavour where as lower level caused flattening of rasogulla balls with surface cracks. Aspartame did not much affect the sensory quality of the product except for its sweetness. No signs of deterioration in terms of flavour body and texture, color and appearance and sweetness of the product were observed up to 20 days at refrigeration temperature and up to 15 days at ambient temperature.

9.0 Kulfi

Frozen desserts are delicate, delicious and nutritious food liked by all age groups throughout the world. *Kulfi* is a popular frozen dessert of Indian origin that occupies a privileged position amongst the traditional Indian dairy products. However, because of its high sugar content (13-20%) there are millions of people who are not able to enjoy the taste of this delicious frozen dessert because of being suffering from diabetes.

Bulking agents and artificial sweeteners are used extensively in the production of diabetic products especially frozen desserts. Technology of the production of artificially sweetened *kulfi* using combination of bulking agents mainly maltodextrine, sorbitol and artificial sweeteners such as Aspartame, acesulfame and Sucralose have been developed. Other traditional dairy products such as burfi, Sandesh and Lassi are being tried to manufacture using different bulking agents and artificial sweeteners.

For production of *kulfi*, standard method of *kulfi* was adopted with slight modifications (Fig. 4). Buffalo milk was standardized to fat SNF ratio of 0.66, milk was than concentrated under atmospheric condition to 32% total solid, bulking agents were added to impart bulk and the body. Aspartam was selected as artificial sweetener and maltodextrin as well as sorbitol were used as bulking agent. *Kulfi* mix was flavored with cardamom, filled in mould and frozen in ice and salt mixture. The levels of maltodextrin, sorbitol and aspartame were optimized on the basis of sensory quality and melting rate using CCRD. The level of aspartame had a major impact on sweetness of the product. The body and texture were mainly affected by levels of maltodextrin and sorbitol as they provide bulk to the product where as color and appearance were mainly dependent on the sorbitol level used in formulation. Flavour is mainly dependent on the maltodextrin and sorbitol content.
10.0  Gulabjamun

*Gulabjamun* is a khoa based sweet popular in India. The traditional method of preparation involves blending of *khoa*, refined wheat flour and baking powder into a homogeneous mass so as to obtain smooth dough along with small amount of water. The balls of the dough are deep fat fried in ghee or refined vegetable oil to a golden brown colour and subsequently transferred to sugar syrup. Chetna *et al* (2004) optimized the critical variable of *gulabjamun* preparation using sugar substitutes i.e. concentration of syrup, soaking temperature and duration of soaking using response surface methodology. Based on the optimized conditions gulabjamun without sugar could be prepared without affecting the quality of product. Soaking of fried *gulabjamun* balls in sorbitol syrup of 54°F strength added with aspartame @ 0.25% maintained at 65°C for 3 hrs yielded the good quality product.

11.0  Shrikhand

*Shrikhand* an acid coagulated indigenous and sweetish-sour, fermented milk product is a popular delicacy in Gujrat, Maharastra and part of Karnataka. It is consumed as a dessert. This indigenous dairy product is prepared by lactic acid coagulation of milk, syneresis of whey form curd followed by blending of sugar flavour colour and spices. Traditionally *Srikhand* is made from chakka by adding sugar, flavour and milk fat. This product has very high amount of sugar. This product has very high content of sugar (≥40). The effect of sugar replacers on sensory attributes and storage stability of shrikhand (Singh and Jha, 2005). Among various combinations of sugar and raftilose tired, *shrikhand* prepared with raftilose (4%) and sugar (12.5%) was rated as most acceptable by the sensory panels. Sugar and raftilose exhibited a significant effect (p<0.01) on flavour, body and texture and overall acceptability no significant effect was observed on color and appearance.

12.0  Suggested Readings


1.0 Introduction

The concept of milk and milk products in India can be tracked back to the Vedic age. The milk or gorus (the elixir from cow) was referred in many rituals; the concept of Panchamrit (Milk, Dahi, Ghee, Honey and Sugar) was referred in Vedas. From the time immemorial, the milk and milk Products have enjoyed an eminent position in Indian food, which had been matured through the ages. Now they have become inseparable part of cultural fabric of India, and all the processions beginning from birth to death are marked by milk sweets. Boxes of sweets are considered harbinger of good news, in fact a Bengali sweet Sandesh (means Message) must accompany the mail sent in olden days. Today the range of Traditional Indian Sweets represents the cultural diversity of India, the richness, the highest tradition of hospitality joy, love, affection, respect and so may emotions which are beyond the bound of the words along with the purity and nutritional aspects.

The beauty of Indian traditional food was its quality, safety and nutritional aspect; but with increase in population; the food safety was left far behind. Considering this Government of India had enacted Food Safety Act 2006 (Mother of all Foods Laws) in Monsoon session of Parliament; signed by the President of India in Aug 06; which is coming into force from 01/01/07. Hence the need of the hour is to respect food safety or pack-up the business.

In Sep 2005; ISO 22000 (ISO 22000 = ISO 9001:2000+HACCP) came into existence; which is a comprehensive Food Quality and Safety Standard. But the GMP is the most important pillar of HACCP.

Good Manufacturing Practices (GMP) is a supporting pillar of HACCP (Hazard Analysis Critical Control Point). HACCP has become synonymous with food safety. It is a worldwide recognized science based systematic and preventative approach that addresses biological, chemical and physical (and now quality also) hazards by anticipating and preventing, rather than by finished production inspection.
As per CODEX; HACCP is a system which identifies, evaluates, and controls hazards which are significant for food safety. It is:

- Systematic
- Guided by scientific evidence of risks to human health
- Identifies specific hazards and measure their control
- Focusing on Prevention (rather than relying mainly on end-product testing)
- Is capable of accommodating change (e.g. advances in equipment design, technological developments)

HACCP is not a stand alone system; it must be accompanied by:

1. Good Manufacturing Practices (GMP)
2. Standard Sanitation Operating Practices (SSOP)
3. Other Pre-requisite Program: Training; Product Recall Procedures; Supplier Control Activities; Service and Maintenance Program; etc.

2.0 HACCP

The following sequence of 12 steps is the recommended approach for the development of a HACCP program. This logic sequence has been agreed to at the international level by a HACCP working group of Codex alimentarius (WHO/FAO). The seven basic principles of HACCP are indicated in the brackets.

1. Assemble HACCP team
2. Describe product
3. Identify intended use
4. Construct process Flow Diagram and Plant Schematic
5. On-site verification of Flow Diagram and Plant Schematic
6. List hazards associated with each step - (principle 1)
7. Apply HACCP decision tree to determine CCP - (principle 2)
8. Establish critical limits - (principle 3)
9. Establish monitoring procedures - (principle 4)
10. Establish deviation procedures - (principle 5)
11. Establish verification procedures - (principle 6)
12. Establish record keeping/documentation for principles one through six (principle 7)
3.0 Prerequisites

Prerequisite programs are defined as universal steps or procedures that control the operational conditions within a food establishment allowing for environmental conditions that are favorable to the production of safe food.

The importance of the prerequisite programs cannot be overstated. Prerequisite programs are the foundation of the HACCP plans and must be adequate and effective. If any portion of a prerequisite program is not adequately controlled, then additional critical control points may have to be identified, monitored and maintained under the HACCP plans.

In summary, effective prerequisite programs will simplify HACCP plans and will ensure that the integrity of HACCP plans are maintained and that the manufactured product is safe. I am elaborating this because in most of the HACCP plans this is covered in GMP manual only; i.e. they have HACCP manual; GMP manual and SSOP manual, no prerequisite manual per se.

The six (6) prerequisite programs include:

1. **Premises**
   - Outside Property
   - Building
   - Sanitary Facilities
   - Water/Steam/Ice Quality Program

2. **Transportation and Storage**
   - Food Carriers
   - Temperature Control
   - Storage of Incoming Materials, Non-food Chemicals and Finished Product

3. **Equipment**
   - General Equipment Design
   - Equipment Installation
   - Equipment Maintenance and Calibration

4. **Personnel**
   - Training
   - Hygiene and Health Requirements

5. **Sanitation and Pest Control**
   - Sanitation Program
   - Pest Control Program

6. **Recalls**
   - Recall Procedures
   - Distribution records

4.0 GMP in Milk Sweets Manufacturing Units

4.1 GMP at Primary Produce Level (Farm to Plant)

In this chapter we will not go in detail; but to brush up; the major points are.
1. Personal health and hygiene
2. Health of dairy animals
3. Hygiene of milking practices and production hygiene
4. Hygiene of holding and storage practices
5. Hygiene of transportation and collection; and fulfillment of temperature requirements

4.2  GMP at Secondary Level (Production Plant)

The most important portion of our GMP starts here:

4.2.1  Location of processing establishment

The processing plant shall meet the following requirements:

(a) Site: The processing plant shall preferably be situated in open, clean, and healthy surroundings away from roadside where lot of dust arises due to vehicular traffic: garbage dumps; cattle sheds; open sewage drains or other places likely to breed flies, it shall also be free from sources of obnoxious fumes, smoke, or excessive dust. It should not be there at the areas subject to flooding; prone to infestation of pests; areas from where wastes, either solid or liquid can not be removed effectively. There shall not be accumulation of fresh, garbage or similar waste in the vicinity of the plant.

(b) Building: Structures housing the Processing Plant shall be suitable in size, construction and design to facilitate maintenance and hygienic operations for processing purposes. It should provide sufficient space for housing of equipment and storage materials (raw as well as finished products) necessary for hygienic operations. The material of construction shall be of brick, plaster, cement, concrete, tile or any other equivalent materials which ensure cleanliness. Construction of the building shall be such that it shall be rodent prod, fly proof and bird proof. No portion of building shall be used for domestic purposes or other types of food operations unless separated by suitable partitions or locations or other effective means.

4.2.2  Layout and Design of Process Establishment

Adequate Separation including Clean and Dirty Processes

1. The flow of raw materials, work in progress, finished product, personnel and equipment through the plant should be as linear as possible.

2. Storage of raw materials and packaging must be segregated to avoid cross contamination and must be separated from the product in production areas.

3. Where segregation is difficult, for example in small, open plan factories, good process flow layout is critically important. The risk of cross contamination may be greatly reduced by the use of physical barriers such as partitions (single skin only) or specific layouts of floor machinery requiring adequate space.
4. There must be complete physical separation of the high and low risk areas in terms of raw materials, products and personnel. The incorporation of filtered air supplies, positive air pressure and appropriate personnel controls are recommended to maintain the integrity of high-risk areas. This includes facilities to change clothing on entering the department.

4.2.3 Drainage - Good Repair, Dirty and Clean Separation

Drains in a milk processing plant play a very vital role in establishing GMP and subsequently food safety

1. The capacity of the drains must be sufficient to cope with the maximum process requirements placed on them.

2. The floors must be adequately drained with the fall of the floors carefully designed to ensure that all liquids flow towards proper drainage channels. There shall be no standing pools of liquid. These could be minimized by using PVC pipes. The slope of the floor should be towards the drains and the farthest end of the floor from the drain should not be more than 5 meters. Effective drainage shall be provided to drain off a large quantity of water shed for washing *be machinery, equipment, furniture, floor etc;*  

3. **15 to 30 cm** half circular drains with glazed pipe at the bottom should be provided. Drainage channels that are half round in section with both the drains and gullies covered with removable easily cleaned grids are recommended.

4. The drain opening should be provided with screen traps to prevent solid matter from clogging the drains. The ends of the drains lending to the outside of the factory should be made rodent proof by providing screens. The screens shall be examined periodically and replaced or cleaned, if necessary.

5. The drains should have water seals of minimum 5 cm. At least 50 per cent of the length of the drain should be covered to facilitate the movement of trolleys. **Mesh type** for the drain should be better to prevent habitation of cockroaches and rodents in closed areas of the drain.

6. Drainage entry and exit points into the building must be pest proofed. Fumigation of drains is acceptable.

7. In high-risk premises, the flow of the drains shall be from high to low risk to avoid contamination of the clean environment.

8. **Positioning of machinery** in relation to access to drains shall not compromise regular cleaning.

9. **Adequate debris traps** should be fitted to all drains *at suitable places before they are connected* with the municipal drain to avoid blocking or choking and any manhole covers properly greased and sealed. Damaged drains must be repaired as quickly as possible to prevent any blockages or accumulation of debris.
4.2.4 Sitting of Equipment

1. All machinery should be positioned to give easy access to all parts for cleaning. Equipment must be at least 50cm from adjacent walls.

2. Equipment must be designed and laid out to minimise any possible contamination from external sources.

3. All frameworks in and around equipment should be in **tubular sections** to minimise accumulation of debris and to facilitate cleaning and reduce the risk of infestation e.g. with maggots, molds and ants.

4. Machinery mounted on the floor must be installed on a foundation of easily clean-able, non-absorbent material. It must be either properly sealed to the floor with sealing material which is resistant to the environment or raised off the floor to allow access underneath for cleaning purposes, particularly to drains.

4.2.5 Condition of Floor

1. The floor shall be smooth, washable, properly sloped to gullies connected to sewers or drains. Floors should be designed to withstand the rigours of the production processes that are being conducted.

2. Floors must be in good condition and must be laid using Hard, smooth and impervious materials with an even, easily cleaned surface which is free from cracks, pitting and open joints e.g Terrazzo.

3. The floor surface must be impervious to moisture and grease, resistant to chemicals (not affected by weak acids, alkalis or steam) and food materials to which it may be exposed and safe to walk on when wet, dry or greasy i.e non-slip surface.

4. Floors must be kept clean and free from the accumulation of water or other spillage’s, especially in corners and areas hidden by equipment, materials etc.

5. Coved wall and floor junctions should facilitate cleaning.

6. Damaged flooring must be repaired as quickly as possible with materials compatible with the original flooring and in a permanent fashion. Temporary measures must be rectified with an action plan in a specified time.

7. Where mezzanine floors are adopted, they should be completely sealed and include side walls of adequate height. Drainage within these floors should be completely self-contained and there must be no risk of contamination of machinery or products sited below.

8. Any stairways to or from mezzanine floors or gangways over production lines must be sealed and include side walls to prevent product contamination.
4.2.6 Condition of Walls, Doors and Windows

1. All interior walls in rooms where open food is stored or processed must be smooth non-absorbent light-coloured surface, free from crevices and sharp angles, to facilitate their efficient cleaning. It must be in good condition and finished with a hygienic, easy to clean surface, which does not pose a foreign body hazard e.g. walls should be finished with a continuous, bonded surface and protected from damage.

2. Corners, joints between cladding sheets or ceramic tiles must be sealed with a suitable impervious sealant i.e. the junction of the floor with the walls and junction between the two walls shall be rounded to prevent accumulation of dust.

3. Walls and wall surfaces should be free from shelves and other protruding attachments wherever possible. The design must be such as to avoid any horizontal surface, which could act as a dust trap, or impromptu shelf space.

4. All wall-wall and wall-floor junctions should be coved. Wall-ceiling junctions and other junctions should be coved or sealed to facilitate cleaning.

5. All signs of deterioration and damage should be dealt with immediately and the repairs should be compatible with the original finish.

6. Where notices are required they should not be nailed, pinned or taped to walls, self adhesive notices or food grade painted notices are preferred in production areas.

7. Recommended that walls must be protected in vulnerable areas by the use of guard-rails. Services must be sealed into any walls through which they pass e.g. electrical fittings, plumbing etc. Where fabricated walls are used, services must be sealed onto them e.g. electrical fittings.

8. Where temporary walls are constructed, they must give adequate protection from contamination and they must not present a hazard to the process or the product.

9. All external-opening doors must be kept closed. Where frequent use makes this impractical then either automatic doors, rubber swing doors, plastic strip curtaining or air curtain should be provided to prevent bird and insect ingress.

10. All doors to production areas should be self-closing to maintain the necessary atmospheric conditions. They should be close fitting on all sides and the doorframes and corners must be given protection against damage.

11. All windows should be kept closed. Those required to be opened to provide additional ventilation, should have the total opening area screened with a mesh small enough to exclude flying insects.

12. All exterior windows must be clear, complete and properly fixed. Their frames must be of sound fitting and completely sealed to prevent insect ingress.

13. Broken or cracked windows must be replaced immediately before production recommences. Approved shatterproof materials must used.
14. Windowsills and ledges should be sloping to prevent tools and other articles being placed on them.

4.2.7 Condition of Ceiling and Lights

1. In any room where open food is stored or processed, the condition of the ceiling must be smooth, easily cleaned and kept in good repair. It must not pose a foreign body hazard to the area below.

2. Ceilings may be under drawn or suspended, however, access must be provided to the void above to enable adequate cleaning and pest control inspections. Adequate walkways must be provided for this purpose and also for access to services.

3. All junctions between walls and ceilings should be sealed and impermeable to facilitate cleaning. Additionally eaves and ridges must be sealed to prevent access to birds, insects and rodents.

4. Where painted surfaces are unavoidable, both these and underlying surfaces must be sound and free from flaking, and repainted as necessary with a paint approved for use in food preparation areas.

5. Girders and overhead framework must be regularly maintained and cleaned, where possible these should be of circular cross section to aid maintenance and to prevent a build up of dust and debris.

6. Throughout production and inspection areas, good artificial lighting must be provided. Fluorescent strip lights should be protected by shatterproof diffusers or sleeve covers in production areas. Any other form of lighting must be protected such that glass contamination of product is rendered impossible.

7. Natural daylight tubes must be used in inspection areas, otherwise adequate lighting must be provided for operations.

8. Where special lighting conditions are required, for example on inspection belts, lighting of the correct colour and intensity must be provided.

9. All light units must be kept clean, and bulb replacement or any other maintenance programme carried out when the department is not in production.

10. Skylights should be designed to prevent access by pests, and must not be directly above any exposed raw material or finished product. If movement of production lines results in them being placed below skylights, then a canopy should be provided to protect the product or the light screened.

4.2.8 Ventilation Adequate, Removes Heat, Steam etc

1. Adequate temperature and dust control must be provided in all areas.

2. In steamy atmospheres, extraction fans must be provided to give adequate ventilation and minimize condensation and drippage. This will help to prevent
mould formation on walls and ceilings and could also reduce the level of corrosion on fabric and equipment.

3. In dry areas, dust extractors should be installed where necessary. These units must be regularly inspected and maintained to ensure that they are functional and that there are no signs of infestation.

4. Frying or other fume producing processes must be provided with adequate extractor facilities, trapped to prevent condensate falling back into the process.

5. Condensate from extraction systems and from evaporators, must be plumbed direct to drain, and the collection system sanitised daily.

6. Both ventilation systems and extraction systems must be kept scrupulously clean to avoid introducing contaminants into the process environment.

4.2.9 Condition of Service / Overheads, Redundant Items Removed

The processing room should have:

1. The room shall be made fly-proof and rodent-proof.

2. The processing rooms shall be provided with elf effective means to prevent the entry of flies and insects. Such effective means may be screens, fans, air curtains, etc.

3. The Processing room should provide with self-closing double doors.

4. The doors and window should be covered with fly-proof wire gauge, and they should be open outwards.

5. The floor shall be impervious to water and shall have a sufficient slope to ensure drainage.

6. Instruments and working equipment intended to come into direct contact with raw materials and products shall be made to corrosion-resistant material and easy to clean and disinfect.

7. All water used in food factories whether for processing, cooling or pre-cleaning of cans, bottles or jars and for rinsing process equipment must be of potable quality and free from discoloration or taint. Its microbiological and chemical quality must be regularly checked.

8. Water tanks must be kept covered, frequently inspected to ensure that there has been no contamination and must be regularly cleaned.

9. Where chlorination is necessary, contact time and free chlorine levels must be routinely monitored.

10. All compressed air supplies must be filtered and passed across water and oil traps which should be drained regularly.

11. All services should ideally be routed down from ceilings, structures and services running below the ceiling must be kept to a minimum and be regularly cleaned.
12. All overheads must be maintained in good condition i.e. free from rust, flaking paint or masonry and free from cobwebs, dust and other accumulations of debris.

13. Steam lines must be adequately trapped and checked for carry over chemicals.

14. All pipework lagging must be kept clean and complete. Redundant pipework should be removed together with other redundant services.

15. Electrical trucking and cable trays must be kept free of dust, cobwebs etc.

16. Hoses must be kept in clean and hygienic condition. Wall mounted reels should be fitted for storage and they should always be kept off the floor.

17. Steam hoses must never be immersed in product. If live steam heating is required, the hose must be fitted with a stainless extension tube.

18. Regular audits of service lines, particularly water must be carried out to eliminate dead legs.

4.3 Good Standards of Decoration

Throughout the site there should be evidence of good standards of decoration and the implementation of a maintenance programme. Signs of deterioration such as chipped tiles, flaking paint, and damaged plasterwork should be limited and should definitely not be evident where they present a risk to the product.

5.0 Facilities

5.1 Water

Water is often the most common source of contamination. Almost all levels of operations use water in their processes in one form or the other. All water used should be as per WHO latest specifications.

1. In contact with food: Only potable water, should be used in food handling and processing, with the following exceptions: for steam production, fire control and other similar purposes not connected with food; and in certain food processes, e.g. chilling, and in food handling areas, provided this does not constitute a hazard to the safety and suitability of food (e.g. the use of clean sea water).

2. Water recirculated for reuse should be treated and maintained in such a condition that no risk to the safety and suitability of food results from its use. The treatment process should be effectively monitored. Recirculated water which has received no further treatment and water recovered from processing of food by evaporation or drying may be used, provided its use does not constitute a risk to the safety and suitability of food.

3. As an Ingredient: Potable water should be used wherever necessary to avoid food contamination.

4. Ice and Steam: It is very often mistakenly believed that owing to their inherent
temperatures ice and steam do not constitute a source of food hazard. Studies have shown that they constitute the most frequent source of contamination in food. Ice should be made from water that complies with IS 4251:1967. Ice and steam should be produced, handled and stored to protect them from contamination. Steam used in direct contact with food or food contact surfaces should not constitute a threat to the safety and suitability of food.

6.0 Personal Requirements (Personal Hygiene)

In traditional food industry; as the manual work is more than the machine work; hence the personal practices and hygiene become very significant in ensuring GMP.

1. Every person employed in connection with production; handling, processing and distribution of milk shall be medically examined for infectious diseases; skin ailments; Respiratory disorders once in a year or more frequently. A record of such examination shall be maintained.

2. All employees who are in direct or indirect contact of milk products shall be inoculated and vaccinated against the enteric groups of diseases at suitable intervals. A record shall be maintained. No worker shall be allowed to work without proper clothing and foot wear.

3. Employees shall be provided with clean uniforms or aprons or both and clean disposable caps. Separate room or place for changing the clothes shall be provided. The clothes shall not be hung in any processing room. The uniforms shall not be worn outside the plant but put on just before starting the work and changed when leaving.

4. Eating, spitting, nose cleaning or the use of tobacco in any form including smoking or chewing betel leaves shall be prohibited within the processing, packing and storage area of the dairy. Note to this effect shall be prominently displayed and enforced.

5. Sufficient and suitable sanitary Conveniences shall be provided, maintained and kept clean. The conveniences shall be properly lighted. Separate conveniences shall be provided for each sex. No convenience shall open directly into any work room in the dairy. The conveniences shall always be maintained clean and in good repairs.

6. Sufficient number of wash basins with adequate Provision of nail brushes, soap and towels, latrines and urinals the prescribed manner should be provided, conveniently situated and accessible to workers at all times while they are in the dairy. The wash basins shall be installed in or alongside the sanitary Convenience.

7. Effective hair restraints shall be worn by employees engaged in the preparation or handling of products to prevent the contamination of food or food contact surfaces.

8. The nails should be clipped; shaving; personal grooming etc. should be made a habit; it should be regularly checked and a record of the same shall be maintained.
9. Proper way of handwashing should be known to everyone and to be followed by everyone.

7.0 Conclusion

GMP is a self designed rule; the pest management part is not covered in this chapter as a separate topic; because all the clauses referred above in case of surroundings; layout; drainage systems etc. are meant for pest exclusion; i.e. the pests and rodents should not enter the production area. There are a few simple points to conclude with:

- HACCP is a team effort; it needs commitment from each and everyone in the organization.
- Prevention is better than cure; and HACCP is a preventive approach. HACCP don not guarantee food Safety; but it indicates the manufacturer’s due diligence in ensuring safety of food.
- All the points referred above are indicative and not exclusive; the GMP manual for each organization is different; and it is governed by the type of organization and its process.
- Always search for excellence; and “excellence comes from the demand of unreasonableness”. i.e. if you want to achieve excellence always demand unreasonable.
1.0 Introduction

Paneer, a highly popular traditional Indian dairy product, is obtained by acid- and-heat coagulation of milk. The phenomenon of coagulation involves formation of large structural aggregates of milk proteins in which milk fat and a small fraction of whey carrying soluble milk solids are entrained while the major portion of the whey (the watery liquid) separates from the coagulates. The solid mass resulting from fusing together under pressure, of the coagulated lumps, is Paneer. A white colour; sweetish, mildly acidic, nutty flavour; spongy body and a close-knit texture characterize good quality paneer. Paneer is highly nutritious since it retains about 90% fat and protein, 50% minerals and 10% lactose of the original milk. Though the composition of market samples of Paneer varies to a large extent, the product prepared by adopting a standard method on an average contains approx. 54% moisture, 18% proteins, 25% fat, 2% lactose and 1.5% minerals. According to the Prevention of Food Adulteration Act (1954), Paneer shall contain not more than 70% moisture and the fat content should not be less than 50% of dry matter.

Annual Paneer production in India in the year 1998 was estimated at approximately 300,000 tonnes (Mathur, 1998), which represented about 2% of total milk production. Paneer has many uses starting from its consumption in raw form to preparation of several varieties of culinary dishes and snacks. The demand for the value added products with Paneer as the base material is growing at a very fast rate particularly in the urban areas. There is a further need to tap the market potential of Paneer both for domestic consumption as well as export. The brief overview of Paneer manufacture, factors affecting Paneer quality, process modifications and mechanization, shelf life of Paneer, and also uses for whey, the byproduct from Paneer making is presented in the following sections.

2.0 Batch Process

The main equipments needed for commercial manufacture of Paneer using the conventional process include: milk storage tank, cream separator, steam-jacketed vat (or cheese vat), curd press and heat sealing/packaging machine. Services required are steam, water and chilled water. Size and type of the plant and machinery depend on the capacity of the manufacturing unit.

The heating and coagulation of milk is done in a stainless steel double walled vat as shown in Fig 1. Stirring is done manually with a ladle. In case of a large vat, a mechanical
agitator is fitted with a motor. At the bottom of one side of the vat, a drain-valve is provided to drain primary (free) whey after coagulation while secondary whey (entrapped) removal takes place during subsequent pressing of the curd separately. Steam supply line is equipped with a safety valve and a pressure gauge, and a water line is provided at a junction in the steam line to supply hot water into the jacket of the vat. To obtain a uniform temperature in the jacket, an H-shaped diffuser is provided in the bottom. It is also provided with over flow line open to atmosphere. This enables release of pressure in the jacket, if any. The vat is of sanitary design. After draining the primary whey, the curdled mass is collected in hoops lined with a muslin cloth and weight is applied (Fig 2). In the traditional method, weight is applied for 15-20 min to allow secondary whey to drain-off. The matted block is then cut into pieces and dipped in the chilled saline water. Paneer, thus obtained is suitably packaged.

In the process of developing a domestic gadget for Paneer-making, studies on whey drainage and matting of curd were carried out using a test-cell. (Mudgal, et. al, 1995 a & b). Based on the findings a batch unit for handling milk up to two litres was designed and developed at NDRI, Karnal (Fig 3). This Paneer-making gadget has an inbuilt curd pressing mechanism based on spring-loaded device. The drained whey and the matted Paneer cake remains inside and protected from outside environment. Both of these are removed as per the need. The Paneer block of 3 cm thickness weighing about 500 g was considered the choice for domestic level requirement. The same unit could be scaled-up to handle 8-10 litres of milk at a time and produce a Paneer block of 2 kg size. This size of the unit is particularly suitable for restaurants. Such innovation will alleviate the need for preservation and unhygienic ways of Paneer production.

3.0 Continuous Process

Batch production at a small scale employing the traditional process, often results in an inconsistent quality and poor hygienic conditions. For mechanized production in a continuous mode, some existing equipment meant for similar products could be adopted, of course with modifications. Tofu, which is similar to Paneer, is extensively produced in Japan. The equipment line for Tofu can be adopted for production of Paneer. The Alpma fresh cheese plant has also been tried. By the precise pH control on moving rubber conveyers the desired curdling of milk could be obtained. The system permits flow regulation for milk and acidulant, mixing and curdling. The coagulum is filtered over a drum-filtering unit. The whey and the dewatered curd are collected in hoopes. However, pressing of partial dewatered curd are addressed separately through a slow revolving press. It is an adopted system from cheese making.

A continuous Paneer-making system (Fig 4), recently developed at NDRI is based on the twin-apron conveyor design. In this system, the unit operations involved in Paneer making have been mechanized. The system consists of i) supply of pre-conditioned milk at a desired flow, ii) acid supply and dosing, iii) transverse jet mixer-reactor (TJM-R), and iv) continuous dewatering and matting system for producing Paneer cake of 3 cm thick (Agrawala, et al., 2001). The machine is designed to manufacture 80 kg Paneer per hour by employing twin-flanged apron conveyor cum filtering system for obtaining the desired moisture content and texture attributes.
The existing technological approach for production of such coagulum is based on the traditional manufacturing technique of coagulating milk by acid and heat in a steam-jacketed vat. In the traditional process coagulation starts before the entire mixing process is complete, which leads to lesser solids recovery and a lower yield. Due to shear force generated by intense agitation, the already formed coagulum starts disintegrating and this affects final product texture. As traditional process is purely batch type, there is variation in quality from one batch to another. Being batch process, it involves extensive manual labour and also makes the process unhygienic. On the other hand, in the present continuous system, complete mixing occurs prior to the start of coagulation, which leads to greater product recovery and better textural quality. Being a continuous process, product obtained is of uniform quality. The new system gives a hygienic product as mixing of acidulant and milk takes place in-line at T-junction in the TJM-R leaving no scope for atmospheric contamination (Shekhar Patel, 1998). The coagulant supply unit consists of stainless steel tank with agitator. Steam is used for indirect heating of the acidulant. Both the above units are connected through a TJM-R wherein effective mixing of milk and acidulant takes place; subsequently, the coagulum is fed into the dewatering unit.

The milk conditioning and supply unit consists of a plate heat exchanger with provision of heat regeneration, heating of milk from 25°C to 90±2°C holding for two minutes and cooling to 70±2°C. This heat treatment is sufficient to denature whey protein for a maximum product recovery. Other accessories in this unit are of appropriate sizes/capacities such as balance tank, pump, flow meter, temperature indicator and auto thermal control unit, etc.

The continuous dewatering and matting unit consists of twin apron conveyor to carry out primary and secondary filtration in the same machine. The lower conveyor is flanged type while the upper one is unflanged type. The flanged unit has perforations for drainage. The additional fine filter of appropriate size is placed over the conveyor to prevent the solids loss. The linear speed of the conveyor is so designed that it gives the residence time required for adequate dewatering. Flexibility in the motion is incorporated through a variable speed drive, giving 5-8 min of residence time. Automation in pH control and optimum applied pressure during matting of curd is under development. Increasing the width of conveyor can increase capacity of this unit.

4.0 Conclusion

Paneer is a popular heat-and-acid coagulated milk product of Indian origin. About 2% of total milk production in India is utilized for the production of Paneer and its demand is increasing at a very fast rate. It a highly nutritious product containing on an average 18% milk proteins, 25% fat and 1.5% minerals. Variety of culinary dishes and snacks are prepared from Paneer in addition to its direct consumption. Paneer of good quality can be made from both buffalo and cow milk though the former is more suitable. Equipment for mechanized and continuous manufacture of Paneer has recently been developed.
5.0 Suggested Readings


![Fig.1 Paneer Vat](image)

![Fig. 2 Traditional Process of making paneer at small scale](image)
1. Feed tank
2. On-line filter
3. Feed pump
4. Plate heat exchanger supply
5. Holding tube for heated milk
   a) Regeneration system
   b) Heating system
6. Hot water
7. Acidulant tank
8. Acidulant pump
9. Flow control
10. Flow diversion valve
11. Rotameters
12. Temperature indicators (T1 and T2)
13. Transverse jet mixer-reactor

Fig. 3 Line diagram of continuous coagulation process with application of TJMR unit
14. From TJM-R  
15. Primary whey drainage  
16. Entrance of curd pressing zone  
17. Upper conveyor  
18. Lower apron conveyor  
19. Scraper  
20. Paneer outlet  
21. Wet scrubber  
22. Fixed conveyor shaft  
23. Adjustable conveyor shaft  
24. Whey outlet  
25. Adjustable support  
26. Spray nozzles  

Fig. 4 Curd Dewatering Unit
1.0  Introduction

Milk - a perfect food both for man and microbes is vulnerable to spoilage if not cared for. The art of conserving this perfect food by applying various preservation principles has resulted in development of an array of dairy products, many of which have become globally popular whereas others have remained country and / or region specific. Although India’s indigenous milk products belong to the latter category, these are gaining steadily increasing popularity in the other parts of world too.

The exact origin of Basundi is not known, but it has been prepared over several centuries in the western and southern parts of India. Basundi is a popular milk dessert in Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu. It is served during special festivities such as weddings and religious festivals. It is analogous to rabri and khurchan, which are popular in the northern and central parts of India.

Basundi is a heat-desiccated, thickened milk dessert, having white to light caramel colour, creamy consistency with soft textured flakes that are uniformly suspended throughout the product matrix. Basundi has a sweetish caramel aroma. Consumed directly as a dessert, it contains all the solids of milk in an approximate two-fold concentration plus additional sugar, with high food and nutritive value. It is garnished with spices, nuts and condiments. The total production of Basundi is estimated at about 25,000 Tones per annum, which is mainly confined to the cottage scale in the non-organized sector. With the rapid growth of dairy industry in our country, the technology and design of process equipment has also undergone needed changes and equipment for making indigenous products are no exception. The small-scale technology for the preparation of indigenous products cannot be exploited for industrial production.

Standardization of traditional process in terms of manufacturing techniques, sensory profiles, and compositional and physico-chemical attributes is necessary for attaining a product of uniform standard and assured quality.

2.0  What is Basundi?

Basundi or Basundhi is defined as a preparation of boiled and sugared milk (cow or buffalo), used mostly in western and southern parts of India. The IDF defined the product as a confectionery based on concentrated milk. Basundi has an appearance like condensed milk with flakes i.e. thin flakes in a thick fluid. It has a light brown colour, a smooth consistency
with presence of very minute suspended flakes resembling that of plain condensed milk and having pleasant, cooked and nutty flavour. Recently Pandya et al. (2006) have critically covered various aspects of Basundi.

3.0 Existing Technology

Buffalo milk is preferably used for Basundi owing to its high content of solids. Traditionally, Basundi is prepared by heating whole milk at simmering temperature in a shallow karahi over gentle fire. Milk is thickened through evaporative heating with occasional scraping at the bottom. As a thin skin forms on the surface of the hot milk, it is periodically removed by means of khunti, and set on the cooler side of the top of the karahi. With progressive boiling, more and more of the skin is formed, which is removed and collected on the top sides of the karahi. When no more skin is formed and the milk is concentrated to the consistency of the condensed milk, sugar (about 15-17% of concentrated milk or 5-6% of initial milk quantity) is added in to milk and stirred until it is fully dissolved. At this stage, the collected semi-dried skins from the top of the pan are scraped and mixed in to the concentrated remnants of milk. The pan is removed from the fire, allowed to cool and the flavouring materials added, and stirring continued till the desired plastic consistency is achieved. The product is cooled and served chilled.

4.0 Standardized Procedure

Patel (1999) carried out systematic studies to develop a standardized procedure for making basundi on commercial scale. He studied various aspects of basundi making such as (1) Market survey of Basundi (2) Standardization of composition/recipe, viz., Rate of sugar addition, Total solids level, Selection of type of milk and Fat/SNF ratio (3) Selection of processing parameters, viz., Preheating of fresh and chilled (stored) milk, Homogenization and Method of concentration, (4) Exploring the possibility of using alternate source of milk solid viz., sweet cream butter milk (SCBM), (5) Selection of packaging material, (6) Application of post production heat treatment, (7) Consumer preference, (8) Heat induced changes in milk during Basundi manufacture and (9) Costing of Basundi.

Based on the above studies Patel and Upadhyay (2004) recommended that for the manufacture of Basundi, buffalo milk giving good heat stability to at least 65% (v/v) ethanol should be selected and its fat, SNF and acidity should be checked. The milk is to be standardized to Fat/SNF ratio of 0.50 ± 0.01 and preheated to 90°C, 10 min before concentration in batch type steam jacketed stainless steel open, wide mouth pan. The steam pressure in the jacket initially should be maintained to 1.0 kg/cm\(^2\) and constant scraping cum agitation should be continued till the milk is partially (i.e. ~2 X milk TS) concentrated. The cane sugar is added at this stage @ 5%, w/w of milk. Thereafter the concentration is carried out at slightly lower steam pressure (~ 0.8 kg/cm\(^2\)) with continuous agitation till final concentration of ~2.5X the original TS including sugar is reached.

The product may be homogenized (75 kg/cm\(^2\), 65°C) and Na\(_2\)HPO\(_4\), 2H\(_2\)O stabilizer can be added @ 0.3% w/w. The final TS of the product be standardized in between 45 to 46%. The Basundi so prepared is hot (≥ 55°C) filled in glass bottles and after sealing the bottles
are heat treated to 90°C, 10 min and then cooled to ~10°C and subjected to refrigerated storage (~7±2°C) till consumed.

5.0 Composition


The average composition of Basundi was fat 11.52 %, SNF 18.67 %, protein 7.70 %, lactose 8.12 %, ash 1.33 %, sucrose 16.43 %, TS 46.62 % with a fat:SNF ratio of 0.62. The average values of physico-chemical properties were: acidity 0.36 %, pH 6.6, FFA 0.56 μeq/ml, HMF 10.79 μmol/l, a_w 0.96, specific gravity 1.12 and viscosity 75.24 mPa.s.

Organoleptically, the Basundi having light brown colour, a smooth consistency with presence of very minute suspended flakes resembling that of plain condensed milk and having pleasant, cooked and nutty flavour was preferred the most.

Basundi prepared by the standardized process of Patel (1999) contained fat: 11.61 %, protein: 9.86 %, lactose: 11.47 %, ash: 1.72 %, SNF: 23.05 %, sucrose: 12.69 %, total solids: 47.35 %, fat:SNF ratio: 0.50. They also reported desirable physico-chemical properties required in Basundi. They are: Acidity: 0.46 % LA, pH: 6.57, FFA: 1.35 μeq./ml, HMF: 15.51 μmol/l, Browning index: 0.18 OD/g TS, Water activity (a_w) at 25°C: 0.979, Specific gravity at 20°C: 1.13, Viscosity at 18°C: 52.96 m.Pa.s and Insolubility index: 0.30 ml, Alcohol number: 57.00 and – ve COB test.

6.0 Shelf life

When Basundi manufactured by standardized process as described by Patel and Upadhay (2004) was packed in glass bottles or PP (Poly Propylene) cups remained in good condition upto 25 days at 7±2°C (Patel et al., 2005) whereas when post production heat treatment (PPHT) given either in hot water bath (90°C, 10 min) or by autoclaving at 105°C for 10 min yielded the product which remained good upto 40 days storage at 7±2°C.

7.0 Microbiological Quality

Microbiological analysis of market samples of Basundi revealed a total bacterial count ranging from 2.0 x 10^2 to 13.3 x 10^5/g and presence of coliforms (Venkatasubbaiah and Dwarakanath, 1985). Under laboratory conditions Patel and Upadhay (2004) observed total viable count in Basundi initially from 2x10^3 to 23x10^7 at the end of 50 days storage. Thermoduric count observed was from 2 to upto 22x10^3 during this period. When post-production heat treatment was not given to the Basundi samples studied, the Total Viable Count increased from initial 15x10^3 to 300x10^6 and the Yeast and Mould Count increased from 0 to 300x10^6 during the storage period of 30 days. (Patel et al., 2005).
8.0 Design and Development of Continuous Basundi Making Machine (CBM)

The commercial large-scale production of Basundi with very good sensory properties has necessitated sincere efforts in developing suitable equipment for the same. The CBM is designed based on the principle of Scrap Surface Heat Exchanger (SSHE). It consists of concentration unit of three SSHEs and chilling units of two SSHEs with specially designed scrapers, Variable Frequency Drive (VFD) to facilitate variation of speed of scrapers, Resistance Temperature Detector (RTD) sensors and other controls to optimize processing parameters, which results in to better quality product in terms of sensory and rheological attributes.

SSHEs are commonly used in the food industries for better heat transfer, crystallization, freezing and other continuous processes. They are ideally suited for products that are viscous, sticky and that contain particulate matter. Since these characteristics describe a vast majority of processed foods, SSHEs are especially suited for pumpable food products. In SSHEs, during the operation, the product is brought in contact with a heat transfer surface that is rapidly and continuously scraped, thereby exposing the surface to the passage of untreated product. In addition to maintaining high and uniform heat exchange, the scraper blades also provide simultaneous mixing and agitation. Heat exchange for sticky and viscous foods such as Basundi, ice cream, margarine, chocolate, peanut butter and shortenings is possible only by using SSHEs. High heat transfer coefficients are achieved because the boundary layer is continuously replaced by fresh material. Moreover, the product is in contact with the heating surface for only a few seconds and high temperature gradient can be used without the danger of causing undesirable reactions. SSHEs are versatile in the use of heat transfer medium and the various unit operations that can be carried out simultaneously.

SSHEs are most suitable choice for handling high viscosity products with or without particles, and for the products that tend to foul the heat transfer surface. SSHEs can overcome all the problems associated in the batch process and handles viscous products smoothly without affecting the heat transfer coefficient.

Patel et al. (2006) developed a machine for continuous production of Basundi. The new technology using Standard Process (SP) and CBM is energy efficient and the quality of the product is better compared to traditional product as concentration of milk takes place at atmospheric pressure and sugar syrup dosing in the third SSHE of concentration unit develops typical pleasant caramel flavour. Simultaneously it is also expected that the process consumes less energy and has least deleterious effects on the nutritional profile of Basundi. This method of manufacture of Basundi using SP and CBM offers several advantages over traditional method of Basundi making such as (1) Continuous production and possibility of scale-up of production (2) Uniform quality of the product under hygienic conditions (3) Energy efficient without pollution, as there is no use of coal/wood for heating, which is very common in traditional methods, here we are using steam as heating medium (4) CBM is designed based on the concept of Scrap Surface Heat Exchanger (SSHE), which gives better heat utilization, high overall heat transfer coefficient, higher thermal efficiency and lower cost of processing, (5) The sensory quality of the Basundi made by using standard process is superior compared to Basundi made by other methods (6) CBM has provision of re-use of
water vapour produced from milk to pre-heat the milk, which makes the machine more energy efficient and helps to conserve energy, (7) Basundi is chilled immediately to have better shelf-life and rheological properties, (8) CBM has better process controls due to incorporation of sensors and controls like RTD, VFD etc., (9) CBM is suitable for commercial production of Basundi with better compositional, physico-chemical and rheological attributes, (10) Cost of processing by CBM is almost 50% less than that of traditional method and (11) CBM overcome limitations of conventional method of Basundi-making, viz. non-uniform heating and agitation, lack of rheological quality, labour and time intensive process, energy intensive process, small scale and un- economical commercial production.

The new technology using Standard Process and CBM is energy efficient and the quality of the product is better compared to traditional product as concentration of milk takes place at atmospheric pressure and sugar syrup dosing in the third SSHE of concentration unit develops typical pleasant caramel flavour.

The design and development of CBM Machine, based on the principle of thin film scraped surface heat exchanger is energy efficient and the quality of the product is better compared to traditional product as concentration of milk takes place at atmospheric pressure and sugar syrup dosing in the third SSHE of concentration unit develops typical pleasant caramel flavour. Standard process used for Basundi making helps to attain a product of assured uniform quality. The average score of the product was 93/100 on hedonic scale. CBM is energy efficient and under optimum operating conditions gives lower cost of processing i.e. approx. 50% less than conventional method. It gives uniform and hygienic quality, better sensory attributes and higher profit margin compared to other methods.

9.0 Suggested Readings

ORGANIC MILK AND MILK PRODUCTS : SCOPE AND CHALLENGES

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1.0 Introduction

Organic agriculture which includes dairy farming means an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony.

Organic foods are becoming available in an impressive variety, including pasta, prepared sauces, frozen juices, frozen meals, milk, ice cream and frozen novelties, cereals, meat, poultry, breads, soups, chocolate, cookies, beer, wine, vodka and many more. Global market for organic foods (OFs) is growing at an impressive rate of 20-30 % annually. The current market of OFs has been estimated to US$ 30 billion. USA alone has 12 billion US$ market, followed by Europe (10-11 billion US$), Japan (3 billion US$) and other countries (7 billion US$). The estimated Global market would be 100 billion US$ by 2010 (ITC Study 2004). The health conscious population of this elite group of developed countries requires OFs at premium prices as evident from future projected estimates. India’s share in world market is very decimal i.e. 0.001%.

2.0 What is Organic Milk?

Organic milk refers to the process by which it is produced, not to the product itself. Organically-produced and conventionally-produced milks are identical in many aspects, viz. composition, nutritive characteristics, taste, etc. Organic production methods aim at recycling resources and promoting biodiversity and these aims are valued by some consumers. However, all milks regardless of how it is produced must meet the same strict standards for content, wholesomeness and product safety. Marketing claims that organic milk is different from and better than conventionally produced milk has not been scientifically substantiated (www.nationaldairycouncil.org, www.ams.usda.gov, www.eatright.org).

Organic milk production involves the rearing of milch animals on feed and fodder grown in farms using only organic inputs. Consumers perceive that organic milk is tastier, healthier and more natural than conventional milk. Although many perceive "organic" to mean "pesticide-free" or "hormone-free", it in fact refers to the management system, not the final product. It is based on minimal use of off-farm inputs like veterinary drugs for animal health care and non-use of fertilizers and pesticides for fodder/feed production. With the growing awareness among the educated middle and upper middle classes in India, there
appears to be good scope for production and marketing of organic milk, particularly in metropolitan cities.

According to the U.S. Department of Agriculture’s (USDA) standards, milk and milk products can be labeled "organic" if the milk is from cows that have been exclusively fed organic feed, are kept in pens with adequate space, are allowed periodic access to the outdoors and direct sunlight, are not treated with synthetic hormones and are not given certain medications to treat illness.

Organic feed is harvested from fields that have adhered to the USDA's organic regulations for pesticides, herbicides and fertilizers for at least three years. While proper animal care and environmental stewardship are priorities for all dairy farmers, marketers using the term "organic" must ensure that all of the above criteria are met and follow the Federal Drug Administration’s (FDA) labeling guidelines (www.floridadairycouncil.org / documents / OrganicBackgrounder.doc)

3.0 Nutritive Profile of Organic milk

Several scientific studies have demonstrated the nutritional benefits of organic milk. They show that organic milk generally contains higher levels of beneficial nutrients and vitamins than milk from non-organic cows. The diet of organic cows significantly contributes towards the nutritional benefits of organic milk. Organic cows eat a much more natural diet mostly consisting of fresh grass and clover (forage). In comparison, non-organic dairy farmers are allowed to use more grain-based (concentrate) feed containing cereals, maize and protein supplements. These diets increase milk yields but also effect the nutritional composition of the milk as well as the health of the cows.

Organic standards aim to ensure that cows and other livestock are reared on organic feed for the quality of milk they produce, rather than just maximizing quantity. This is why at least 60% of their daily diet must consist of roughage for example fresh or preserved grass (EU, 1991; 4.7). In addition, to guarantee that their food is as fresh as possible at least 50% of their feed must be grown on the farm itself or on linked holdings.

3.1 Vitamins and antioxidants in organic milk

The higher level of beta carotene and tocopherol found in organic milk have a range of nutritional benefits in disease prevention and control. The compound alpha-tocopherol is part of the vitamin E family. Vitamin E has antioxidant properties that mean that it can prevent damage by free radicals that cause cancer. Studies have shown that dietary intake of alpha-tocopherol "may be protective against cardiovascular disease, mutagenic alteration and cancer" (Bergamo et al., 2003). Vitamin E is known to prolong the shelf life of milk since it acts as an antioxidant.

4.0 Organic Foods in India

During the past few years, consumer demand for organic food has risen dramatically in the wake of a series of high profile scares about food safety. Though a limited number of
studies have compared the nutrient compositions of organically and conventionally produced crops, with a very small number of studies that have compared animal products including meat, milk and dairy products produced under the organic systems. Organic production systems are very strict in adherence to quality norms, and subject to inspection and certification regarding who produced it, how it was processed, how it was marketed. All these concerns are important towards making a product 'organic'. Organic is not only a matter of final product but the whole process of production has significance under the organic production systems.

In India the consumers concern with environmental and health impacts of agriculture is now picking up. With the growing awareness to health hazards coming from foods, the consumer are now primarily interested in buying organic food products for their perceived healthy attributes. Modern and educated consumers in India are also increasingly considering information on the safety and process i.e. how foods are produced. The organic food industry is undergoing tremendous expansion worldwide. Now time has come to consider the marginal socio-economic effects with emphasis on environmental costs and benefits of transition from conventional to organic milk production while maintaining a constant level of milk production. In a survey in our country, it has been shown that organic vegetables were preferred for reasons of freshness, taste and perceived nutritional value. Some consumers are prepared to pay more for the vegetables, but they have to be assured that the products are truly organic. All consumers wanted organic vegetable production to continue on the Institute farm. It is concluded that this study reflects the trend in developing countries for organic production and development activities for sustainable agriculture.

Consumers concern in our country with environmental and health impacts of agriculture are now picking up. Increasingly, food safety and quality especially associated with presence of pesticide and antibiotic residues, and heavy metal contamination even in branded soft drinks and bottled water, have become evident now.

5.0 Features of Organic Milk Products

Overall it may be said that organically produced milk and milk products in particular find it difficult to become widely established. This is due to the fact that milk and milk products already enjoy a thoroughly positive image as regards naturalness, originality, good taste and product safety. Today, the consumer needs more convenient food products, like individual portions and ready to eat meals. The food service is growing, and in these kinds of products, the organic origin is difficult to valorize. However, organic milk and dairy products can be an important part of a balanced diet and they are produced without the use of added chemicals;
- No antibiotics
- No added growth hormones
- No dangerous pesticides
- No genetically modified organisms
- No artificial flavors, synthetic colors or preservatives
- No hydrogenated or partially hydrogenated oils.
The consumption of organic milk and milk products is part of a larger trend. This development has occurred due to major changes in life style, such as:

- Greater interest/awareness of health issues
- Increased interest in the environment
- Increased individualism
- Increased mobility

Organic dairy products offer a wide variety of delicious organic milk, yogurt and cheese products that provide an excellent source of calcium, which is also believed to reduce the risk of osteoporosis and kidney stones.

In addition to providing calcium, organic milk and dairy foods are an important source of other vitamins and minerals. They are high in phosphorus, and are a good source of both protein and vitamin A. Besnier, a French Company, entered the organic market in 1995 with its Lactel UHT milk, and since then has launched organic brands of yoghurts Cre/Grace/Me Fraiche, butter Camembert and fresh pasteurized milk. The various companies involved in production of organic dairy products include Triballat Noyal, French market leader for organic fruit yoghurts; Laiterie Le Gall producing a range of 21 organic milk products including yoghurts and butter and Laiterie d’Armor, which produces a wide range of organic yoghurts, cheeses, desserts, butter, cultured milks and fresh milks. Domaine de la Croix Morin is the largest producer of organic milk and milk products in France, producing organic liquid milk, yoghurt and fresh cheese. Petit-Suisse Camembert, butter and L+lactic acid products containing Lactobacillus acidophilus and Bifidobacterium bifidum. The organic milk products market has been fundamentally changed by the arrival on the scene of major players, such as Besnier, Sodiaal and leading retail chains.

Organic yoghurt is popular in Switzerland and the marketing cooperative advises farmers to grow varieties of cooking cherries for fruit yoghurt. Ten to fifteen per cent production of Toni Holding SA, the largest milk processing company in Switzerland is organic. Its main areas of production are: fresh milk products 44.5 per cent, butter 17.1 per cent cheeses 15.4 per cent and dried milks 7.5 per cent. One-third of the organic milk at Rocombe Farm, Torbay and Devon, goes into an ice-cream business and the remainder to ‘Pastures Pure’ organic milk sales. Naturnaelk Cooperative Dairy founded in 1994 at Broderup, Denmark, is now manufacturing organic cheese, Gou-Dan cheese. The organic dairy producers’ cooperative founded in 1988 in Halfing, Germany, provide organically produced milk to three cheese factories. Twelve types of organic cheese are being produced including semi-hard cheese varieties, hard cheese, fresh cheese and white-brined cheese. Gelati Betrona, an European company, launches organic ice-cream, which is now being introduced in Italy.

A number of companies are now involved in producing organic fermented milk products. Besnier, a French Company, has launched organic brands of yoghurts cre/grace/me fraiche, butter Camembert and fresh pasteurized milk. Triballat Noyal, the French company now is a market leader for organic fruit yoghurts. Laiterie Le Gall producing a range of 21 organic milk products including yoghurts and butter and Laiterie d’Armor, which produces a
wide range of organic yoghurts, cheeses, desserts, butter, cultured milks and fresh milks. Domaine de la Croix Morin is the largest producer of organic milk products in France, producing organic liquid milk, yoghurt, and fresh cheese. Petit-Suisse produces Camembert, butter and lactic acid products containing Lactobacillus acidophilus and Bifidobacterium bifidum.

6.0 Status of Organic Milk and Milk Products in India

Switch over to organic milk production may be far easier for Indian livestock farmers in comparison to their European counterparts, where traditional production has arrived at a very high level of input dependence, with an overdose of antibiotics, pesticides, feed additives, etc. The low external inputs based Indian dairy sector has better prospects to translate to organic production since majority of Indian farmers are organic farmers not by choice but by default. A modest commencement has already taken place, particularly in supplying organically produced fruit, vegetable and milk to meet the demands of some special sectors including 5-Star hotels in our country. The Integrated Rural Development Programme (IRDP), an Aurangabad based NGO attempted to establish organic dairy in its premises. Besides, some Goushalas/ Ashrams also claim to produce milk in organic way. The scenarios of exporting organic milk from developing countries are ever improving. Already, India is exporting organic tea, coffee, herbs, spices, cotton yam, pulses, rice, etc. Being the global boss in annual milk production, our country can venture in the global organic market.

Overall, the fact that quality consciousness among the Indian citizens is mounting and the motivation to pay extra for quality is also visible. In the recent past, some optimistic steps have been taken by GOI especially by developing National Standards for Organic Production (NPOP). The launching of National Programme for Organic Production in March 2000 is also a significant signpost for boosting organic production in our country. The Agriculture and Processed Products Exports Development Authority (APEDA), ICAR, State Agricultural Universities (SAUs), State Departments of Agriculture coupled with the NGO’s, are now working towards promoting organic production.

7.0 Indian Strategies for Organic Food Products

Conversely, the production of organic products is stagnant. Strategies that should be adopted in the Indian dairy industry to meet rising quality standards include quality control. Sales of organic foods are one of the fastest growing segments of different Western countries. In response to growing demand for information on organic confidence, first, one can work to ensure that the natural foods in their stores are consistent with the standards. Second, they can make an effort to incorporate the concepts behind the natural foods movement into their strategic planning i.e. adding organic product promotions to advertising plans, and by taking account of the environmental implications of their own operations. In addition, by working in concert with other retailers, trade organizations and appropriate non-profit organizations and governmental agencies, mass-market retailers can help create a healthy business environment for natural foods in the long term. Organic food manufacturers should begin to widen their marketing options by diversifying into different retail outlets.
Due to the constraints facing market acceptance of organic products, pioneering organic farmers should create their own closed marketing networks, from production to consumption.

8.0 Challenges

In view of the Agreements on Agriculture, Sanitary and Phyto-sanitary (SPS) measures and Technical Barrier to Trade enforced by the World Trade Organization (WTO) dealing with trade practices, food safety and regulations concerning plant and animal health, it is imperative that strict control measures conforming to international standards, guidelines and recommendations need to be taken in all aspects of manufacture, storage and distribution of CBS. Codex standards specify the maximum permissible limits (MRL) for various pesticides residues, veterinary drugs, chemical contaminants, toxins in dairy products. In significantly large cases, the codex MRL are more stringent than those prescribed by PFA Act in India. Widespread use of antibiotics for treating animals in India may influence the MBR time of raw milk. Under SPS agreement, application of HACCP has been recommended to minimize microbial count, growth and contamination in milk and milk products. European Union has introduced many directives to control import of dairy products by its member countries from outside. Two such important directives are EC 92/46 and EC 93/43. The former aims to regulate the production and marketing of dairy products and also fixes the responsibility of food safety onto the producer while the latter governs the hygiene of foods and recommends application of ISO 9000 standards and HACCP system to achieve the objectives. It is suggested that a Good Manufacturing Practice (GMP) needs to be followed in a dairy plant before implementing HACCP. GMP is very pertinent to dairy industry and can be applied at all stages from the procurement/production of raw materials through intermediate products to final products to make the food safe and wholesome. But we do not have proper GMP guidelines suitable for our dairy industry. A number of dairy plants in India have already received certifications of HACCP Food Safety Management System and Integrated System of ISO 9000 Quality Management System. Indian dairy industry also needs to adopt ISO 14000 standards which comprehensively cover environmental issues and aim to promote international trade by removing or reducing non-tariff trade barriers. It is apprehended that possession of environmental management certification may be treated as a prerequisite in future for allowing organizations to operate in global market.

PFA Rules specify standards for chhana but do not suggest any standard for most of the CBS which makes it difficult to prevent possible malpractices in the manufacture and marketing of these products. As a result, there is wide variation in the quality of such products in the market place. Critical evaluation of energy requirements during the manufacture of various CBS is also necessary to develop energy efficient processes and equipments.

The individual entrepreneur engaged in the manufacture of CBS in small scale sector is not geared to handle a large volume of products due to various reasons including economic consideration. These processors produce less quantity of CBS than the critical quantity required to be manufactured if mechanized system is used. Since the body and texture characteristics of different CBS vary a lot, one or two machines would not be able to serve the purposes of small entrepreneurs as far as processing or packaging of these products are
concerned. Further, if a product is packaged before selling, it needs to conform to various legal provisions such as declaration of ingredients, composition of the product, preservative and/or colour, if any, used etc. on the package which the small entrepreneurs find difficult to fulfill. Most of the business houses, therefore, prefer to sell the products without packaging.

9.0 Conclusion

India has a great potential to show its strong presence in world OFs market. It has an edge over other developed countries due to its large and ecologically diversified cultivating land (21 agro ecological zones) cheap and hardworking manpower having traditional knowledge base and old traditional varieties/breeds (biodiversity) developed through ages based on organic norms; strong infrastructure for dairy production and processing; and more.

Organic milk and milk products are very strong and potential players in world OFs market. India has all resources and technology to take the challenges of producing organic milk particularly in hilly regions of North –East using indigenous breeds of cattles and buffaloes. The organic milk thus produced could be collected and converted in organic indigenous milk products (OIMP) with ISO 9000, HACCP and Organic Certification for high value export market.

All the stakeholders should join hands at a common platform to plan a targeted approach to achieve the goal of making a significant dent in World OFs market.
1.0 Introduction

Domestication of animals for milk production in a nomadic way was started some 6000 years ago. Traditional techniques for preserving surplus milk under tropical conditions were developed around the same time. With the growth of civilization and knowledge base, newer ways for conserving surplus milk were innovated for home use. The traditional products with relatively longer shelf-life than that of milk became the items of choice amongst households, pilgrims and visitors. Although the production methods for the traditional products were based on kitchen experience, with progress of time many of them took the shape of tradable commodity. **Halwais** (sweet makers) have greatly contributed to the process of evolution of hundreds of varieties of milk food delicacies with innumerable flavours, texture, shape and size, colour, appearance and packaging materials.

Indian milk products are classified as (i) concentrated and heat desiccated, (ii) acid and heat coagulated with drained whey, (iii) fermented, (iv) fat rich, (v) frozen and (vi) cereal-milk based mixes. A newer generation formulated, convenient, ready-to-use and ready-to-eat traditional dairy products have recently been developed by the Indian dairy scientists. Irrespective of kind, most of these products are found deficient in quality and safety aspects.

2.0 Weaknesses of Traditional Dairy Products

The traditional dairy products prepared by indigenous methods are labour intensive and energy inefficient. Because of lack of control on the quality of raw materials and production process, the products are of inconsistent chemical composition and textural properties. The products handled under unhygienic conditions are found to carry high microbiological load. At time they are contaminated with pathogenic microorganisms. Cases of food poisoning consequent to consumption of inferior quality sweets are reported especially during rainy season and summers. Most products suffer from low shelf-life as a result of total absence of packaging and lack of refrigerated facility during storage, transportation and distribution.

No wonder that the indigenous milk products are produced daily for local consumption alone and some producers have earned reputation for selling products of good quality. Ask them the meaning of quality and they would say that a good quality product is one that consistently meets the needs of the consumer at the lowest cost of production.
Because of severe shortage of skilled manpower, during olden days, low or unskilled worker approach was the only practical option for preparation of traditional products with a narrow job scope. The modern concept of quality in traditional dairy products has started only recently with growing demands in the towns and cities and strengthening of food laws enforcement agencies in the country. There are many Indian food delicacies for which quality standards have not been laid down so far in the food regulations. The Ministry of Health has specified the microbiological quality for major traditional milk products during the year 2005. Time is given to the manufacturers to upgrade their food safety management systems.

3.0 Unsafe Food

“Unsafe Food” means an article of food whose nature, substance or quality is so affected as to render it injurious to health viz.,
- article of food or its package, composed wholly or in part of poisonous or deleterious substances;
- consisting wholly or in part any filthy, putrid, rotten, decomposed or diseased animal substance or vegetable substance;
- processing under unhygienic conditions or presence of harmful substances;
- substitution with any inferior or cheaper substance;
- presence of unpermitted additives, preservatives, colours, flavours, etc.
- part or full abstraction of any constituent (adulteration);
- presence of worms, weevils or insects and extraneous matter;
- misbranded or concealed or unidentifiable foods;
- containing pesticides and other contaminants in excess of quantities specified by regulations

4.0 Identification of Safety Hazards

Food safety has become a major area of concern in domestic as well as export markets. Globally there has been an increasing demand for Hazard Analysis Critical Control Point (HACCP) approach to reduce food borne incidents caused by contaminated products that have implications for human health and an increasing cost to the supplier and to the community. It may be stated that HACCP is not a guarantee of food safety and not a zero-risk system, but is designed to minimize the risk of food safety hazards.

Food safety hazards can be caused by biological (microbiological), chemical or physical agents and cause an adverse health effect. During the identification of hazards, food safety and quality considerations must be differentiated. Presence of allergens and crop contaminants have also found place in safety hazards in recent time.

4.1 Biological Hazards

Most traditional dairy products are at risk from one or more biological hazards that usually originate in raw milk or as a result of poor hygiene during production, handling, packaging, storage and post production. Microbiological hazards like larvae and parasites worms may enter products from contaminated water, human hands and improperly sanitized utensils. Microbiological hazards include,
(i) bacteria (salmonella spp., clostridium perfringens, clostridium botulinum, listeria monocytogenes, camphylobactor, staphylococcus aureus, vibrio cholerae, bacillus cereus, etc.)

(ii) Viruses (Hepatitis A, Rotavirus)

(iii) Fungi (Aspergillus flavus, Fusarium spp.)

(iv) Algae (Dinoflagellates, golden brown algae, blue green algae)

Most microorganisms grow best in pH range of 6.6 to 7.5 and at high water activity levels. Milk nutrients provide optimum medium for microbial growth. Factors affecting the growth of microorganisms will be discussed.

4.2 Chemical Hazards

Chemical compounds are used in milk production and processing chain starting from growing of the raw materials up to consumption of finished products. This may include cleaning chemicals, pesticides, herbicides, toxic metals, nitrates, plasticizers migrating from packages, veterinary drug residues, chemical additives, crop residues, phyllotoxins, bird and animal repellants, rodenticides, wood preservatives and food storage protectors. Allergens and intolerant products can cause allergic reactions within minutes and death within hours. Some food colours, MSG and sulphites can cause reactions similar to allergens. The occurrence and methods of controlling chemical hazards in the traditional dairy products will be discussed.

4.3 Physical Hazards

Like biological and chemical hazards, physical hazards can enter indigenous dairy products at any stage during their production. Physical hazards are normally not found in milk filtered and clarified before use. They may enter the milk products accidentally and may cause illness or injury to the consumers. Physical hazards may include glass pieces, metals, stones, plant leaves, wood, pests, plastic, jewelry, hairs, etc. These hazards can cut mouth and throat, break teeth and cause choking. Illness would be caused by obstruction of bowel, vomiting or irritation of intestine. Perforation of the gastro-intestinal tract can lead to peritonitis.

5.0 Control Measures

Processes and products are classified as either General Risk or High Risk depending upon the potential hazards due to the loss of control during processing. The product categories must be declared by the national food authorities as high risk, medium risk and low risk. Undoubtedly, traditional dairy products may be graded as high risk foods that have a significant likelihood of causing illness or injury to the consumers if they are not properly produced and handled in accordance with the established sanitary operating principles.

The safety of traditional milk products is guaranteed by good agricultural practices (GAP), good animal husbandry practices (GAHP) and good hygienic practices (GHP). Health of udder and animals, quality of feeds and fodders, milking and milk handling
technology, cooling and efficient transport of chilled milk are pre requisite for milk product safety. Accurate testing of milk and milk products, application of HACCP principles and good manufacturing practices (GMP), packaging, storage and distribution would ensure safety. Besides, personnel hygiene should be given importance to minimize contamination of products. In order to build confidence amongst milk producers in pricing, automated methods should be adopted by replacing old fashioned techniques which are vulnerable to human tempering, time consuming, inaccurate and nontransparent.

Physical hazards can be prevented from entering the products by (i) using approved suppliers, (ii) training of employees, (iii) covering of glass fittings with plastic sheets, (iv) prohibiting metal from food handling area, (v) replacing wood, (vi) providing fly screens on windows, keep doors shut, (vii) regular removal of waste, (viii) limiting wearing of jewelry and (ix) following correct cleaning procedures.

Labeling regulations require that the package contains full ingredient declaration, detailed nutritional information, and presence of additives and allergens. Date of production and Best before or expiry date on each product is now mandatory under the Food Safety and Standards Act, 2006 of Govt. of India.

6.0 Conclusion

Because of consumers concern for food safety, growing awareness about health and rising disposables income, manufacture of traditional dairy products must be regulated by a set of standards incorporating minimal use of pesticides, herbicides, hormones, veterinary drugs. Consumers are prepared to pay premium price for safe milk products and milk food delicacies of India known for taste and texture. To be successful in market place traditional dairy products must guarantee freedom from contaminants, adulterants and hazardous substances of all kinds.
1.0 Introduction

In modern times packaging has been identified as an integral part of processing in the dairy and food industry. Package is the gateway to know a product. Packaging is brand ambassador of a product. Packaging is the science, art and technology of protecting products from the adverse effects of the environment. Packaging is a media for safe delivery of the contents from the centre of production to the point of consumption. Packaging serves as a vital link in the long line of production, storage, transport, distribution and marketing. A product is often identified by the package in which it is served (Goyal and Alam, 2004). Package is the physical entity that functions as the barrier between the content and the exterior atmosphere. The package must ensure the same high quality of the product to the consumer. Packaging of products materially contributes to trade promotion and conserves valuable manpower and raw materials. World wide packaging industry is estimated to be more than $300 billion. However the packaging industry is growing at a much higher rate in developing countries, resulting in an overall @ 12% annual growth. In India around 15,000 units are engaged in packaging industry. Projected growth rate of demand and consumption for packaging in India is 10% to 12 % (Anon, 2005).

2.0 Role of Packaging

The packages mainly perform three functions viz. to contain, to protect and to inform / sell the product. It is essential to know the nature and composition of the product, its desired shelf-life under specified conditions of storage in terms of light, temperature, humidity, presence of oxygen, the types and causes of deterioration including mechanical stress, the product may undergo during handling and storage. The ideal packaging material should have the following characteristics (Punjirath, 1995):

- It should not impart its own odour to the product.
- It should be inert to food and must be non-toxic.
- It must protect from moisture, oxygen, and light
- Convenient
- Temper proof
- Printable
- Machinable
- Point of sale impact
- Differentiability
- Economic
The package not only protects the product but also gives information about the contents, storage conditions, methods of use, date of manufacture expiry date, price and nutritional considerations.

3.0 Choice of an Appropriate Packaging Material

The choice of an appropriate packaging material should be governed by factors such as:

- The specific sensitivities of the contents, e.g. moisture, oxygen, etc.
- Factors changing the contents viz. temperature, RH, pH, and the reaction mechanism involved.
- Weight and shape of the container.
- Effect on filling and sealing.
- Speed of unit package.
- Contamination of food by constituents of the packaging material.
- Storage requirement – How long the product needs to be protected?
- Storage condition.
- Biodegradability and recycling potential.
- Transportation mode: Dairy products being a highly perishable product, utmost care is needed in its preservation during storage, handling and transportation.
- There are many more peculiarities, which could be identified under the following headings for, determining the packaging of dairy products.
  a. Product Range Market
  b. Consumer needs
  c. Operating margins

4.0 Traditional Dairy Products

It is estimated that nearly half of the total milk production in India is utilized for the manufacture of a range of traditional milk products viz., fat rich (ghee), heat desiccated (Khoa and Khoa based sweets, Rabri, Basundi, etc.), acid coagulated (Paneer, Chhana and Chhana based sweets), fermented (Dahi, Mishti dahi, Shrikhand), cereal based (Kheer, Payasam etc.) and frozen (Kulfi) products. Most of these products, except 10–15% of total ghee production, are produced by unorganised sector (Halwais) using labour and energy intensive batch processes, resulting into large variations in their qualities. The shelf life of traditional dairy products is generally low and does not commensurate with the principles involved in their manufacture. One of the reasons for poor shelf life is either no packaging or inadequate packaging of traditional dairy products leading to microbial contamination mainly post manufacturing, due to unhygienic conditions in production, packaging and storage areas. A number of surveys conducted on the market quality of indigenous milk products have revealed alarmingly high incidence of microbial contamination, besides large variations in chemical composition, flavour and texture. Most of the indigenous milk products have high water activity leading to rapid deterioration at ambient temperatures. Further, food products exposed to different environmental conditions without packaging get contaminated easily with moulds and bacteria. Improperly packaged foods undergo many flavour and textural changes during transportation and marketing. Lack of knowledge about the nature of food
products and their compatibility with the packaging material may forfeit the purpose and lead to escalation of cost.

5.0 Packaging

5.1 Milk Sweets

In India, it is a common practice to keep the milk-based sweets in open metal trays. On demand, the items are weighed and placed in ordinary paper bags or kept on dhak leaves and given to the consumers. At the most, some halwais or shopkeepers wrap sweets in glassine or greaseproof paper and sell them in duplex board boxes. Also gulabjamun, which is kept soaked in sugar syrup, has no better packaging for local consumption, though it is canned for export purposes. Some of the khoa based sweets namely ‘dhoodhpeda’, ‘carrot halwa’, ‘kalakand’, ‘burfi’, etc. are very common in the northern region of the country. The present trend of packaging of these products is (Alam et al., 2005):

- **Dhoodhpeda**: Paperboard cartons with paper lining, paper bags, dhak leaves.
- **Carrot halwa**: Paperboard cartons, dhak leaves, plastic boxes.
- **Kalakand**: Dhak leaves, paperboard cartons with paper lining, plastic boxes.
- **Burfi**: Dhak leaves, paperboard cartons with paper lining, paper bags, plastic boxes.

5.1.1 Burfi, Peda and Kalakand

Amongst the several khoa-based sweets, burfi and peda occupy most dominating place in terms of popularity and market demand. About 30% sugar (w/w basis) is blended vigorously with hot khoa for making these sweets, but the shape, body and texture and chemical composition (particularly moisture content) of burfi and peda are slightly different from each other. Mostly packaged in paper cartons or duplex board boxes with or without butter paper lining. The traditional packages do not provide sufficient protection to milk sweets from atmospheric contamination and unhygienic handling and thus susceptible to become dry, hard and mouldy and develop off flavours. Also the product packed in these wrappers / packages are not suitable for distant transportation and outstation retail sale or sale through super markets because they lack necessary mechanical and protective properties. Tin containers can be used but their cost is prohibitive. Only recently, some of the reputed manufacturers of these sweets have started packaging burfi and peda in HDPE/polypropylene boxes and cartons of 500g and 1 kg size. The modern flexible polyfilms and laminates offer alternate choice. The chemical composition of the sweet, the transportation hazards, and the period of storage under specified conditions of temperature and humidity are the major factors, which should largely decide the type of packaging materials. The common types of spoilage in burfi, peda and kalakand can be significantly delayed or altogether prevented by using flexible packages.

i) **Defects in Body and Texture**

Burfi contains moisture content ranging from 4.3 to 15.1%, while peda contains 4.2 to 22.3% moisture, and kalakand contains 16 to 28% moisture. At these moisture levels, the sweets have unique texture and typical chewing properties. For storage of burfi, an optimum RH of 70% is recommended. High RH and low RH make the product moist, pasty and hard,
respectively. The choice may be from HDPE, PP, MXXT, polycel or other suitable combinations. This will prevent the ingress of moisture into the product and prevent the products becoming pasty under humid conditions.

ii) Prevention of Rancid and Oxidized Flavours

*Khoa* based sweets are quite rich in milk fat and hence susceptible to rancidity and oxidative changes during storage. Rancidity resembles the sour, irritating, and pungent odour of butyric acid, which is caused by the hydrolysis of milk fat, while oxidized flavour develops due to the action of oxygen with the fatty acid radicals of the unsaturated fats. Proper packaging can play a key role in preventing the rancidity. Among the factors, which accelerate rancidity, light is most effective. Hence, this too should be prevented by using packaging materials having reflecting pigments, denser films. Packaging materials which have very good oxygen barrier properties such as MST cellulose, MXXT, metallized polyester / poly, 5-layer co-extruded films, laminates having Al – foil are recommended for preventing oxidative deterioration. Vacuum packaging of the products also enhances the shelf life to a great extent (Goyal and Rajorhia, 1991).

(iii) Prevention from Discolouration and Absorption of Foreign Odours

*Burfi, peda and kalakand* often lose their original colour and appearance during storage. Light induced oxidation may lead to loss of colour intensity. Maillard type browning – a common storage defect of milk sweets, is also accelerated by exposure to light and moisture. These fat rich dairy products quickly absorb foreign odours and rapidly lose their inherent delicate flavour. It is extremely important that these products are packed in such materials which can stop the two-way traffic of odours / gases in the products in order to preserve their original colour and flavour. Packaging material should also be grease resistant in order to minimise seepage of fat.

5.1.2 Channa Based Sweets

Channa based sweets like *sandesh, rasogolla*, etc. are extremely popular in the eastern and north eastern regions of the country. *Sandesh* is generally packaged in paperboard cartons with a paper lining, ordinary paper bags and Dhak leaves. The *rosogolla* is packaged in tinplate cans, or in paperboards, Dhak leaves, Kulhads etc. Canning of *rosogolla* is expensive and the other methods of packaging are unhygienic, inconvenient and unsuitable for outstation retail sales.

5.1.3 Gulabjamun and Rosogolla

These sweets need to be saved from light, oxygen, ingress or egress of moisture, yeasts and moulds. *Gulabjamun* is a khoa based sweet while *Rosogolla* is prepared from chhana. The similarity between the two is based on their shape, texture and method of storage. Both are spherical in shape, spongy, porous and kept in sugar syrup. Their shape and porosity attributes are very critical and have to be maintained till the product reaches to the consumer. On an average, they contain about 40% moisture and 50% sugar. Fat content in *Gulabjamun* is more than *Rosogolla*. Yeast and mould growth is a more common problem
associated with yeasty / fruity flavour defects during storage in both the sweets. Since the body and texture of *rosogolla* is very delicate and it has to be preserved in sugar syrup, it is invariably packaged in lacquered tin cans of 500g and 1kg respectively. The proportion of *rosogolla* and syrup is kept 40:60 and product stays in good condition for more than 6 months at ambient conditions, because hot filling (at about 90°C) technique is adopted. *Gulabjamun* is largely packaged without syrup in paper cartons or plastic boxes like *burfi* and *peda*. Though lacquered tin can is the most suitable packaging material for *rosogolla* and *gulabjamun*, but it is very expensive. Hence, there is a need to pack these products in composite cans made of plastic and laminated with a PP – Al foil material. The material is heat resistant and suitable for food contact.

5.1.4 Paneer

It is commonly packaged in polyethylene bags and the shelf life of the product is 3-4 days under refrigeration. Recently, some organizations have started its vacuum packaging. In order to increase its shelf life significantly by employing the modified atmosphere packaging (MAP), the research work is in progress at NDRI, Karnal.

5.2 Ghee

Approximately, 35% of the total milk produced in India is converted into ghee. The manufacture of ghee is becoming well organised and centralized. Majority of the dairies are packing ghee in lacquered or unlacquered tin cans of various capacities ranging from 250gm to 15kg. Tin cans protect the product well against tampering and during transportation to far off places without significant wastage. The most common and serious deterioration in ghee is the development of rancid flavour, caused by the formation of volatile compounds, which give unpleasant odour even in micro quantities. The modern packaging plays a vital role in delaying the onset of this defect. The packaging material should also possess good water vapour barrier properties. High-density polyethylene (HDPE) and polypropylene (PP) are known to have low water vapour transmission rates (WVTR), and are easily available and cheap. If such films are laminated to other suitable basic packaging materials, one can get almost negligible value for WVTR, which would be ideal. The package to be selected should show sufficient tensile strength, elongation, tear resistance and burst strength, besides overall good mechanical strength. The packaging of ghee can also be done in polymer coated cellophane, polyester, nylon – 6, or food grade PVC and their laminates.

5.3 Dahi

It is currently packaged in PS cups. This causes slight wheying off during storage, besides pollution problem due to empties. The shellac coated earthen pots are recommended for dahi as the problem of shrinkage during storage is checked and also earthen pots are eco-friendly.

5.4 Kulfi

Kulfi is a frozen dairy product made from desiccated milk, sugar, and flavourings. In India, kulfi industry is developing very fast. It is packaged in aluminium/plastic cones, or tin
cans. Recently the use of earthen pots/cones has been started for the packaging of kulfi. These containers are eco-friendly and their use should be encouraged.

5.5 Dried Milk Products

_Gulabjamun mix, kheer mix and kulfi mix:_ Consumer packages for these products include: sachets and flexibles like metallised polyester (having high barrier properties) kept in cartons.

6.0 Conclusion

Revolutionary changes are taking place at a very fast speed in packaging of food products. Since the demand for convenience foods in India is growing at a rapid rate, it is expected that new forms of packaging material such as roll wraps, pouches, cartons, PP – trays covered with transparent coloured films of MXXT or such other films are likely to appear on the market place for packaging of Indian dairy products. Further, with a view to enhancing the shelf life, thermal processing of certain Indian milk products right in the packages might be successfully attempted. Although, the country has made significant advances in the field of packaging material technology, the packaging machinery has not been developed with the same speed. At present, it is necessary to develop suitable packaging systems for commercial packaging of Indian dairy products. However, due to increased pollution problem, it is essential to shift to eco-friendly packaging of traditional dairy products.

7.0 Suggested Readings


1.0 Introduction

Ghee occupies a very significant place in Indian diet. The nutritional value of ghee is known since Vedic time in ancient India. Ghee is an indispensable part of religious and ceremonial functions. The major markets for ghee are located in south Asian countries. Ghee is also consumed in Australia, Arabian countries, USA, UK, Belgium, New Zealand, Netherlands and many other African and Asian countries.

Traditionally in Indian households ghee is made first by converting milk into dahi, churning it at room temperature to obtain makkhan or desi butter, clarifying the desi butter accumulated over a period of time and conversion into ghee by boiling it continuously at temperature upto 110-120\degree C depending upon the regional flavour preferences. Making of ghee in the presence of milk proteins yields high levels of conjugated linoleic acids (CLA) which are known to be anticarcinogenic agents. Ghee made traditionally contains as high at 5 times CLAs as compared to original milk fat in milk. CLAs are also known to be antioxidants and are responsible for higher shelf life of ghee at ambient temperatures (Aneja and Murthi, 1990).

The quality of ghee is described in terms of flavour, texture and colour. The consumers of ghee always look for most desirable sensory attributes and freedom from suspended serum residues. They also want an assurance of purity, freshness and wholesomeness. Rajorhia (1980) reported that consumers’ preferences for ghee in India varies from region to region. The findings have been given in Table 1. Ghee manufacturer should be able to use this information for commercial applications.

Post WTO scenario presents a big challenge before the Indian dairy industry where competition from overseas manufacturers in global market has become unavoidable. Although Ghee is our indigenous product, besides meeting the international standards it should be manufactured in a manner that is cost effective with considerable savings in energy and without affecting the sensory and shelf life attributes.

For manufacture of ghee, there are many methods, such as Desi or indigenous or traditional method, Creamery – butter method, Direct cream method, Pre-stratification method and Continuous method (Rajorhia, 1993). Comparison of these methods is given in Table.2.
Nearly, 90% of the ghee produced in the country is made by traditional method. Increased awareness about energy management in past motivated the research works to develop energy efficient and continuous methods for ghee manufacture (Punjprath, 1974), which include either an oil separator (Bhatia, 1978) to separate serum and fat phase or use of scrapped surface heat exchangers (Abhichandani, et al., 1995). Both the processes save energy and yield a comparable product.

2.0 Continuous Method of Ghee Making

Dairy plants have tried to modify, scale-up and adopt the traditional batch process for commercial production. Although large quantities of ghee are made by this process, there is a long felt need of a continuous plant. One of the ways is to adopt the established process for producing butter oil involving centrifugal separation of moisture followed by final dehydration under vacuum. However, the product would lack typical ghee flavour.

As an alternate to such system, a scraped surface falling film heat exchanger along with auxiliary equipment such as a melting vat and mechanical clarifier has been developed to serve as a continuous ghee making plant.

Various approaches made for continuous ghee making were directed to achieve the following salient features in the process viz. (1) high heat transfer coefficient and hence compact design (2) better control on quality of product (3) only small holdup of raw material in the plant at any time and hence no changes of whole batch getting spoiled (4) no spillage loss (5) simple, robust and hygienic design (6) minimum strain on the operator (7) facilitate clean in place (8) high degree of automation possible (9) no surface fouling and hence heat transfer coefficient can be maintained throughout the run of the system (10) easy capacity control (11) no foaming problem. Cream can be handled conveniently and (12) economic operation.

3.0 Improved Method of Ghee Making Developed by Panchmahal Dairy.

Under Total Quality Management Programme at Panchmahal Dairy, Godhra, a Small Group Activity (SGA) team was constituted which worked on the improvement in production of ghee making with a special focus on reducing fat and SNF losses.

Firstly, data analysis was done to identify the losses areas, which occurred in ghee manufacture on a big scale. A brainstorming session was conducted on saving the serum solids since fermentation of milk was not carried out and only sweet serum separated out of stratification tank. It was decided that a modification in normal procedure has to be done to recover fat and SNF from sweet serum. To collect fat and SNF from serum, a serum separator was installed for melted fresh butter so that SNF can be directly used in market milk for standardization and fat % of butter be increased and sent to butter melting vat and Primary Settling tank (PST) and thereafter to ghee kettle.

The procedure was finalized with the inclusion of a serum separator and a spiroheater in the process. The details of which are shown in the flow diagram and block diagram. (Fig.1, Fig.2 and Fig.3)
At first, fresh raw milk is received at raw milk receiving dock RMRD of the main dairy plant, chilled and stored. This milk is subjected to cream separation after necessary filtration and warming to 55-60 °C in regeneration section of pasteurizer. Resultant cream is pasteurized in a high temperature short time (HTST) plant at 90-92 °C, chilled to 10-12 °C and stored in insulated, jacketed, cream storage tanks. This cream is then pumped to Continuous Butter Making machine (CBMM) wherein white butter is obtained. Resultant buttermilk along with serum from serum separator is chilled in a plate chiller and diverted for use in standardization of fresh milk.

White butter is pumped via screw conveyor to spiro-heater where it is melted by circulating hot water. Melted butter is conveyed to tanks provided with agitator and hot water circulation jacket from where it is subjected to serum separation. Serum is separated, chilled in a plate chiller and pooled with sweet buttermilk for use in milk standardization. Melted butter with low moisture and high fat and serum solids is collected in a butter melting vat from where it is pumped to Primary Settling Tank (PST) and then continuously to different Ghee kettles (boilers) for ghee manufacturing in a normal way during which residual moisture is evaporated at 113 °C. After some holding, ghee clarification is done at 95 °C through a ghee clarifier to remove fine particles of residue. Clarified ghee is pumped to ghee settling tanks where ghee is cooled with water circulation to 50 °C. At this stage, a sample is withdrawn for analysis with respect to chemical constants and physical attributes before allowing it for packing into retail containers.

The ghee made by our process is fetching premium price in the market. Last year Ghee export was worth Rs. 50 million.

3.1 Advantages of Modified Method of Ghee Manufacture

The quality of ghee made by this new method was studied with respect to marketability involving the tests like colour, flavour, texture and other chemical constants. All were found to be at par with Agmark standards. The team of sensory panelists also carried out the organoleptic evaluation and no difference in comparison with earlier method of ghee manufacture was observed. Hence, it was decided to adopt the new manufacturing process. The benefits obtained by adopting the new method commercially are listed as under:

**Steam saving:** Due to implementation of hot water circulation in spiral heater to melt white butter at 60 °C, some steam was saved. Secondly, in ghee boiler, water to be evaporated reduced drastically as serum solids were removed by serum separator and fat % in melted butter increased to as high as 95 %.

**Increased ghee production:** Reduction in batch making time by two hours resulted due to high fat % in melted butter and less serum part.

**Saving in Fat and SNF:** Serum separated from fresh white butter having 0.8 % fat and 8.0 % SNF was used in milk processing for standardization.

**Load on ETP:** Because of serum separation, SNF in melted butter reduced so quantity of serum residue in the effluent also decreased to a great extent.

**Hygienic condition:** As the circuit for heating through Plate heat exchanger and conveying melted butter is totally closed and a continuous one, the hygienic condition in the ghee section was dramatically improved.

**Delight in working condition:** There was visible delight in the operators and workers of the section because less scraping in ghee boilers was to be done due to less ghee
residue. Ghee filtration was also fast and efficient and ghee batch gets ready in half the time as compared to earlier method. Work of Shop floor got reduced, as section does not get that much soiled as earlier.

**Water saving:** After Ghee boiler is emptied, cleaning is faster and easy resulting in net water saving.

**Overall savings:** As per our estimate, an annual saving amounting to Rs.190 lakhs could be obtained by way of saving in fat/SNF, steam, electricity, man-power, water, hygiene, house-keeping, etc. The saving was calculated by considering 12000 kg. of ghee made in all 365 days of the year (Table 3).

Ghee made by this process has no residue other than ghee fat. Since last five years the Panchmahal Dairy is making ghee using this innovated process.

The average test parameters of ghee made by this process were: Moisture 0.18%, Free fatty acids 0.16% as oleic acid, Reichert Meissl (RM) value 32, Polenske (P) value 1.6, Butyrorefractometer (BR) reading at 40 C is 41-42 and Baudouin’s test negative.

### 4.0 Suggested Readings


Rajorhia, G. S. 1980. Advances in the preservation of ghee and regional preferences for quality. *Indian Dairyman 32:* 745-750

Table 1: Regional Preference for Ghee Flavour and Texture

<table>
<thead>
<tr>
<th>Region</th>
<th>Flavour</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern</td>
<td>Slight acidic, mildly curdy</td>
<td>Fine to medium size grains (½ to ¾ th solid portion)</td>
</tr>
<tr>
<td>Western</td>
<td>Mildly curdy (Strongly curdy in Saurashtra)</td>
<td>Coarse grains of 0.3 to 0.6 mm size</td>
</tr>
<tr>
<td>Southern</td>
<td>Mildly to high cooked, aromatic. Higher level of free fatty (butyric) acid (preference for special herb flavours in Tamil Nadu &amp; Karnataka)</td>
<td>Medium sized grains (Tamil Nadu), Coarse grains (Andhra Pradesh and Karnataka)</td>
</tr>
<tr>
<td>Eastern</td>
<td>Slightly to definitenly cooked flavour</td>
<td>Medium grains (¼th liquid and ⅓th solid)</td>
</tr>
</tbody>
</table>

Source: Rajorhia (1980)
<table>
<thead>
<tr>
<th>Particulars</th>
<th>Indigenous</th>
<th>Cream-butter</th>
<th>Direct cream</th>
<th>Pre-stratification</th>
<th>Continuous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat recovery %</td>
<td>88-90</td>
<td>88-92</td>
<td>92</td>
<td>93</td>
<td>93</td>
</tr>
<tr>
<td>Aroma</td>
<td>Strong nutty</td>
<td>Pleasantly rich</td>
<td>Mild &amp; milky</td>
<td>Pleasantly rich</td>
<td>Mild</td>
</tr>
<tr>
<td>Flavour</td>
<td>Acid</td>
<td>Normal</td>
<td>Cooked</td>
<td>Normal</td>
<td>Flat</td>
</tr>
<tr>
<td>Texture</td>
<td>Packed coarse grain</td>
<td>Slushy fine grain (cow)</td>
<td>Mostly liquid with slight granulation</td>
<td>Fine grains</td>
<td>Greasy</td>
</tr>
<tr>
<td>Clarification using heat</td>
<td>Easy, economic, pre-stratification possible</td>
<td>Easy, economic, pre-stratification possible</td>
<td>Difficult slow, pre-stratification not possible</td>
<td>Easy and economic</td>
<td>Easy and economic</td>
</tr>
<tr>
<td>Essential equipments</td>
<td>Butter churn</td>
<td>Cream separator &amp; butter churn</td>
<td>Cream separator</td>
<td>Cream separator and butter churn</td>
<td>Scraped surface heat exchanger</td>
</tr>
<tr>
<td>By-product produced</td>
<td>Butter milk and Ghee Residue</td>
<td>Skim milk, Butter milk and Ghee Residue</td>
<td>Skim milk, Butter milk and Ghee Residue</td>
<td>Skim milk, Butter milk and Ghee Residue</td>
<td>Skim milk, Butter milk and Ghee Residue</td>
</tr>
<tr>
<td>Adaptability</td>
<td>Small scale</td>
<td>Large scale</td>
<td>Large scale</td>
<td>Large scale</td>
<td>Very large scale</td>
</tr>
</tbody>
</table>

Table 3: Savings Obtained by Innovated Method per ton of Ghee

<table>
<thead>
<tr>
<th>Steps where savings achieved</th>
<th>Traditional method</th>
<th>Innovated method</th>
<th>Savings in rupees per ton/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam consumption</td>
<td>Rs.900</td>
<td>Rs. 300</td>
<td>Rs.600</td>
</tr>
<tr>
<td>SNF recovery</td>
<td>Rs. Nil</td>
<td>Rs. 750</td>
<td>Rs. 750</td>
</tr>
<tr>
<td>Fat loss</td>
<td>Rs. 3000</td>
<td>Rs.Nil</td>
<td>Rs. 3000</td>
</tr>
<tr>
<td>Total savings</td>
<td></td>
<td></td>
<td>Rs. 4350</td>
</tr>
<tr>
<td><strong>Savings per year/ton</strong></td>
<td></td>
<td></td>
<td>Rs. 15.88 lakhs</td>
</tr>
<tr>
<td><strong>Net profit to the plant per annum (12 Ton per day capacity)</strong></td>
<td></td>
<td></td>
<td>Rs. 190 lakhs</td>
</tr>
</tbody>
</table>

Table 4: Details of savings obtained by innovated and traditional methods

A: Savings through steam consumption

<table>
<thead>
<tr>
<th>Innovated method</th>
<th>Value</th>
<th>Traditional method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of 1 kg. Steam</td>
<td>Rs. 3</td>
<td>Cost of 1 kg. Steam</td>
<td>Rs.3</td>
</tr>
<tr>
<td>Condensate obtained for 800 kg ghee manufacture</td>
<td>70 Kg</td>
<td>Condensate obtained for 800 kg ghee manufacture</td>
<td>250 Kg</td>
</tr>
<tr>
<td>70 kg condensate =70 kg steam</td>
<td></td>
<td>250 kg condensate =250 kg steam</td>
<td></td>
</tr>
<tr>
<td>Cost of 800 kg ghee manufacture</td>
<td>Rs. 240</td>
<td>Cost of 800 kg ghee manufacture</td>
<td>Rs.750</td>
</tr>
<tr>
<td>Cost of 12 Tons ghee</td>
<td>Rs. 3600</td>
<td>Cost of 12 Tons ghee</td>
<td>Rs. 10800</td>
</tr>
</tbody>
</table>

B: Savings through SNF recovery

<table>
<thead>
<tr>
<th>Sweet serum solids obtained (0.5 % fat, 8.0 % SNF)</th>
<th>1500 Kg</th>
<th>Ghee residue obtained</th>
<th>135 Kg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value (at the rate of Rs. 6 per Kg. used in standardization of milk)</td>
<td>Rs. 9000</td>
<td>Value (As it goes waste)</td>
<td>Rs. 0</td>
</tr>
</tbody>
</table>

C: Savings by avoiding fat losses

<table>
<thead>
<tr>
<th>Fat loss during ghee manufacture</th>
<th>2 %</th>
<th>Fat loss during ghee manufacture</th>
<th>3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kg. Fat lost in 12 Tons ghee manufacture</td>
<td>240 Kg.</td>
<td>Kg. Fat lost in 12 Tons ghee manufacture</td>
<td>360 Kg.</td>
</tr>
<tr>
<td>Value lost at the rate of Rs. 100 per kg.</td>
<td>Rs.24, 000</td>
<td>Value lost at the rate of Rs. 100 per kg.</td>
<td>Rs. 36,000</td>
</tr>
</tbody>
</table>
Fig 1. Layout of ghee manufacturing system of Panchmahal Dairy, Godhra.
Ghee from GST at 38-40C

Fig 2. Layout of ghee packing system of Panchmahal Dairy, Godhra.
Pasteurized Cream

Continuous Butter Making Machine

White butter from CBM 82 % fat, butter milk 0.7 %fat, 7.5 % SNF

Positive screw driving unit for White butter to Spiro-heater

Spiral heater jacket type hot water circulation at 60° C to melt butter

Melted butter tanks with agitator and hot water circulation jacket

Serum separator

{Butter (90-95 % fat) to butter vat}  {Serum (0.8 % fat, 8.0 % SNF) to milk Process section for standardization}

Primary Settling Tank

Ghee boiling at 113° C (For usual ghee manufacture)

Ghee Clarifying at 95° C (To remove fine ghee residue)

Natural cooling of ghee to 50° C

Ghee Settling tanks

Retail packing

Fig 3. Process steps of a new, modified method of ghee manufacture
1.0 Introduction

India is top producer of milk in the world with an average production of 4 million tones. It is estimated that about 50-55% of the total milk production is converted into traditional milk products. With the rapid growth of dairy industry in our country, the technology and design of process equipment is also undergoing changes. The small-scale technology for the preparation of sweets cannot be exploited for industrial production.

The current method for the manufacture of indigenous dairy products, prominent among which is khoa is based on the techniques that remained unchanged over ages. Regardless of the volume of the production, they are manufactured primarily in jacketed kettles, which inherently suffers from several disadvantages. The equipment employed at the cottage level is enlarged for the industrial level of operation. Consequently inefficient use of energy, poor hygiene, sanitation and non-uniform product quality associated with rural scale operation crept into large-scale manufacture of khoa. The dairy plants adopt this poor method of manufacture due to the nonexistence of processing equipment based on advanced techniques of production and sound engineering principles. Besides the higher profitability dairy products have acquired interest in mass production of traditional dairy products. They have also got great export potential because of GATT agreement, which facilitate free trade through the opening of potential market and reduction in export subsidies. Therefore it is necessary to give priority to the work on the design and development on mechanized systems for the manufacture of traditional dairy products.

Khoa is heat coagulated partially dehydrated whole milk product obtained by heating, evaporation and desiccation at atmospheric pressure. Boiling of milk is continuously done with constant stirring in an open pan till the milk attains a viscous constituency. Thereafter heating is discontinued and stirring continued till the whole mass attains 65-70% T.S.

2.0 Mechanization of Khoa

Since long, various efforts have been made in mechanization of khoa making and are discussed in this article.

De and Ray (1952) described a method of khoa making by taking milk in a Karahi to its 1/5th to 1/4th volume. Buffalo milk was standardized to 5% fat and cow milk to 4% fat and average yield of khoa found to be 21.6% and 13.5% respectively.
Banerjee et al. (1966) developed a semi continuous khoa-making machine which was subsequently modified by De and Singh (1970) and Srinivasan and Rajorhia (1975). The equipment consisted of a SSHE and two open semi jacketed pans with reciprocating spring-loaded scrapers. The equipment had a capacity of 50 liters of milk per hour.

Pal and Gupta (1984) reported that improper release of free fat in cow milk khoa is responsible for sandiness in khoa. A limited proportion of free fat is helpful in providing softness and smoothness to the texture of khoa.

Christie and Shah (1990) developed a three stage continuous khoa-making machine. The machine has three jacketed cylinders placed in cascade arrangement with some slope. The slope allows the movement of contents in longitudinal direction. The heat exchangers are partially open at both ends, which provides a space for the vapors to escape.

National Dairy Development Board has developed an inclined surface heat exchanger (ISSHE) for continuous manufacture of Khoa (Punjrath, et al., 1990). The heat exchanger comprises of inner cylinder, rotor drive and outer steam jacket. In this system the scraper repeats the process of moving coagulated particles from heat transfer surface and mixing them back to the pool of liquid. The angle of inclination of ISSHE permits the formation of pool of boiling milk critical for the formation of khoa.

The convap scraped surface heat exchanger system developed by Alfa Lava has also been used for the manufacture of khoa. In order to impart characteristic body and flavor the concentrated mass at about 90°C emerging out from convap is pumped into a long holding tube. This resulted in excessive power consumption. Moreover at the end of operation some quantity of khoa equivalent to volume of the holding tube remains inside the tube, which is then flushed out at the time of opening. The slurry so obtained is concentrated in batch type heat exchanger.

Rajorhia et al. (1991) compared the quality of khoa prepared viz., ISSHE, Convap-contherm conical vat and roller drier with regards to physico-chemical characteristics, sensory properties, rheological properties and operational features. It was concluded that amongst the selected systems inclined surface heat exchanger proved to be the most appropriate for continuous manufacture of khoa.

Dodeja, et al., (1992) claimed that for handling high viscosity products with or without particles, and for the products that tends to foul the heat transfer surface, the scraped surface heat exchanger (SSHE) is most appropriate choice. Scraped surface heat exchanger can overcome all the problems associated in the batch process and handles viscous products smoothly without affecting the heat transfer coefficient.

In thin film scraped surface heat exchanger, the working fluid is spread in the form of film over the surface by rotating blades. Each blade scoops a certain amount of fluid from the pool and accelerates it along the heat exchanger surface. At any given instant the fluid picked up by blades is partly in the form of a film behind the blade and partly in form of a fillet in front of blade. The blade action, which is similar to that of a plough, causes part of the fluid
to mix with that of the fillet. Simultaneously restoring the film thickness by allowing an equal amount of fluid to squeeze past the tip of blade.

Some unique characteristics of thin film scraped surface heat exchanger are
  — High heat transfer coefficients
  — Narrow residence time distribution
  — Short residence time
  — Wide viscosity range
  — Minimum surface fouling
  — Liquids with foaming tendencies can be easily handled
  — Economy in operation

3.0 Parameters Influencing Performance

The mass of blades and the number of blades influence the heat transfer rate in SSHE. For higher heat transfer rates lighter blades and larger number of blades were necessary. Further improvements to blade indicated that the effect of staggering of blades was similar to increasing their number. Further advantage of staggering of blades was that it reduced the power consumption. Rotor speed above 3.33 rps offered no advantage and added to the power consumption. Residence time distribution studies indicated that the flow inside the SSHE was very close to plug flow and that it was free from common defects such as by passing, short-circuiting and channeling. Such improved flow characteristics are highly desirable in thermal processing of milk.

After conducting large number of experiments with fluid having wide range of physical properties, correlation for heat transferred and power consumption were formulated for thin film SSHE. These correlations have been described elsewhere (Dodeja, et. al, 1990). These equations were employed in designing of thin film SSHE for continuous manufacture of khoa. This simple equipment based on unique concepts as elaborated above formed the heart of the systems subsequently developed for the continuous manufacture of khoa.

4.0 Design features and performance

The continuous khoa making system was designed and developed on the data obtained from concentration of milk to high solids with the help of thin film SSHE. With increasing concentration, as the milk approached semisolid consistency and to process such difficult products, certain innovations were incorporated in the rotor design to achieve simultaneously uniform mixing and continuous forward movement of the concentrated product.

This particular design feature contributed significantly to the success of SSHE’s operation as a continuous khoa making unit. In this, two SSHE’s were arranged in a cascade fashion. The rotor of first SSHE was provided with four variables clearance blades and operated at 3.3 rps. Milk was concentrated in it in the range if 30-35 % T.S. This concentrated product from first SSHE entered the second SSHE, which had different kind of
rotor arrangement. It had two variable clearance blades and two helical blades. Further it was operated at a lower speed of 2.5 rps.

Buffalo milk (fat not less than 5.5%) was standardized for SNF to fat ratio of 1.4:1 by adding required amount of skim milk. The milk was adjusted to 250 kPa in the jackets of both heat exchangers. Milk pump was switched on to permit flow of milk into first heat exchanger. The flow of milk was measured by a rotameter and was kept constant at the rate of 160 kg/h. The final product was collected through the outlet of the second heat exchanger. The samples of khoa were analyzed for chemical and sensory qualities.

The continuous khoa making system was tested for its industrial potential. Large amount of khoa was made by the system. Table 1 gives the chemical composition of khoa made from buffalo milk having 6.2 % fat and 9.77 % SNF.

Table 1: Compositional characteristics of khoa prepared by TSSHE

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Traditional method</th>
<th>Continuous Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat (%)</td>
<td>25.3</td>
<td>25.90</td>
</tr>
<tr>
<td>Total solids (%)</td>
<td>64.54</td>
<td>66.90</td>
</tr>
<tr>
<td>Free fat (% of total fat)</td>
<td>69.35</td>
<td>73.6</td>
</tr>
</tbody>
</table>

It shows that free fat content in khoa made by continuous process was only marginally higher compared to traditional method, despite vigorous agitation in SSHE. The sensory quality of khoa made by continuous and traditional method is shown in table 2.

Table2: Sensory evaluation of khoa

<table>
<thead>
<tr>
<th>Sensory quality</th>
<th>Traditional Method</th>
<th>Continuous Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavor (Max.score 50)</td>
<td>48.5</td>
<td>47.0</td>
</tr>
<tr>
<td>Body and Texture (Max.score 35)</td>
<td>29.5</td>
<td>32.0</td>
</tr>
<tr>
<td>Color and appearance (Max.score 15)</td>
<td>14.0</td>
<td>12.50</td>
</tr>
<tr>
<td>Total score (100)</td>
<td>92.0</td>
<td>91.50</td>
</tr>
</tbody>
</table>

It shows that the khoa made from continuous khoa making machine is similar to that made from batch process.

The energy required in continuous khoa making plant was compared with that in the conventional jacketed kettle (Table 3).
Table 3: Steam consumption during khoa making by TSSHE

| Continuous khoa making (per 100 kg khoa manufacture) | 405 kg |
| Steam consumption | 8kwh |
| Electrical energy consumption | 43 kg |
| (Amount of steam equivalent to electrical energy considering 30% conversion efficiency) | 448 kg |
| Total steam consumption | 514 kg |

Thus there was a saving of 66 kg steam for every 100 kg khoa made.

5.0 Advantages

The system having following advantages

- Higher heat transfer coefficient
- Absence of fouling on heat transfer surface
- No necessity of preconcentrating the feed in evaporator
- Low product inventory
- Equipment adaptable to automation and in place cleaning
- Sanitary operation as process takes place in completely closed system
- No strain on the operator. Only few valves are to controlled
- Uniform product quality as process is continuous
- Waste heat recovery is possible

6.0 Conclusions

Thus it has been demonstrated very successfully that thin film scraped surface heat exchanger has potential to produce large amount of khoa continuously. The capacity of the prototype available is 40-kg/h using buffalo milk and 120 kg/h using 35% concentrated milk. The technology has been transferred to M/s SSP Ltd. Faridabad, a leading dairy equipment manufacture.

7.0 Suggested Readings


1.0 Introduction

Water activity is an important control variable in food processing. It is closely related to the physical, chemical and biological properties of foods and other natural products. Specific changes in colour, aroma, flavour, texture, stability and acceptability of raw and processed food products have been associated with relatively narrow water activity ranges. Water activity has direct effects upon various chemical reactions (Labuza 1980), enzymatic reaction and the proliferation of microorganisms (Troller, 1980). An understanding of sorption phenomenon in foods provides valuable information to characterize storage and packaging problems. Isotherm parameter are needed for evaluating the thermodynamic functions of the water sorbed in foods and are essential in prediction of drying time for food stuffs and in appraising the shelf life of the food products in packaging material.

2.0 Sorption Phenomena in Foods

In biological systems such as foods, water is believed to exist with unhindered and hindered mobility and is referred to as free water, which is similar to liquid water and as bound water. Bound water is generally defined as sorbant or solute-associated water that diffuses thermodynamically from pure water. Bound water has a reduced solubility for other compounds, causes a reduction in the sorbant and exhibits a decrease in its diffusion coefficient with decreasing moisture content. The decreased diffusion velocity impedes drying process because of slower diffusion of water to the surface. Thus the types of interaction between water and food matrix, pH, temperature and other related factors exert a cumulative influence on foods in accordance with their changing values during the course of pretreatment and drying operations (Rizivi, 1983).

In has been established that the actual content of water is not a critical factor in product stability but some other factors related to the ‘nature’, ‘state’ or availability of water determine eventual deterioration. In more general terms, the properties of a food system are influenced by the water-binding energies of specific molecular groups and interaction among hydrophilic chemical constituents. The total binding pressure. At constituent chemical groups are reflected in the equilibrium water vapour pressure. At constant temperature, the vapour pressure may be expressed as equilibrium relative humidity (ERH), the related analogous term water activity (ERH/100) being defined as the ratio of equilibrium vapour pressure to the vapour pressure of pure water at the same temperature.
3.0 Moisture Sorption Isotherms of Traditional Milk Products

An isotherm establishes the equilibrium relationship, at a particular temperature, between the amount of water sorbed and the relative humidity of the environment. At equilibrium, water activity is related to the relative humidity of the surrounding atmosphere by equation.

\[ a_w = \frac{p}{p_0} = \frac{\% \text{ Relative humidity}}{100} \]  

(1)

where, ‘p’ is the vapour pressure exerted by the food material, \( p_0 \) is the vapour pressure of pure water at temperature \( T_0 \) and \( t_0 \) is the temperature of the system.

On the basis of the Van der Waals adsorption of gases on various solid substrates reported in the literature, Braunauer et al., (1940) classified adsorption isotherms into five general types. Moisture sorption isotherms of most foods are nonlinear, generally sigmoid in shape and have been classified as type-II isotherms. Another behavior commonly observed is that different paths are followed during adsorption and desorption process, resulting in a hysteresis. The desorption isotherm lies above the adsorption isotherm and therefore more moisture is retained in the desorption process compared to adsorption at a given equilibrium relative humidity.

The isotherms can be subdivided into three zones each representing a different mechanism for water sorption. In zone C, which corresponds to higher water activities, the influence of insoluble solids on water activity is negligible. The water activity is dependent upon the solute and the water content of the solution phase. In zone B, which corresponds to intermediate water activities, the influence of insoluble solids on water activity becomes significant. The isotherm flattens out and very small changes in moisture content are reflected by very large changes in water activity. In this zone, water is held in the solid matrix by capillary condensation and multiplayer adsorption. Zone A, which corresponds to low water activities, represents adsorption of water on the surface of solid particles. None of the water is in liquid phase. The heat of vaporization of water in this zone is higher than the heat of vaporization of pure water since both heat of vaporization and heat of adsorption must be supplied to remove the water molecules from the solid surface.

The adsorption and desorption isotherms of an Indian dairy products ‘khoa’ at 25°C as reported by Sawhney et al., (2000) are sigmoid shaped of type-II according to B.E.T. classification and the hysteresis effect extends over the entire range of water activities. The initial water activity of khoa is 0.96. There is a steep fall in the equilibrium moisture content of khoa with decrease in relative humidity up to 85%. Between the water activities 0.25 to 0.60 the equilibrium moisture content of khoa remains almost constant. The hysteresis effect in khoa was moderate for the water remains almost constant. The hysteresis effect in khoa was moderate for the water activities less than 0.1. It increased at higher water activities and occurred predominantly in the water activity range of 0.35 to 0.65. The hysteresis effect diminished beyond 0.8 water activity and the adsorption and desorption isotherms of khoa coincided with each other activities above 0.96 at 25°C.
4.0 Isotherm Equations

A large number of equations have been derived to describe the relationship between water activity and moisture content of foods. Since water is associated with a food matrix by different mechanisms in different activity regions, no sorption isotherm model seems to fit the data over the entire water activity range (Labuza 1975). Some of the MSIs are therefore described by semi empirical equations with two or three fitting parameters. The B. E. T. isotherm equation (Brunaner et al., 1938) is a most widely used model and gives a good fit to data for a variety of foods over the region 0.05 < aw < 0.45. The B. E. T. equation is generally expressed in the form

\[ \frac{a_w}{X (1 - a_w)} = \frac{1}{X_m C} + \frac{C - 1}{X_m C} a_w \]  

(2)

Where \( a_w \) is the water activity, \( X \) is the equilibrium moisture content (g water/100 g solids), \( X_m \) is the mass fraction of water equivalent to monolayer of water covering the surface of each particle. \( C \) is a constant at constant temperature and is related to the heat of adsorption of water on the particles. \( C \) is temperature dependent.

A detailed collaborative study of water activity of foods undertaken by the European Economic Community in the project titled COST-90 recommended the Guggenheim-Anderson-de Boer (G.A.B.) model for wider range of water activities. The G.A.B. expression may be written as:

\[ \frac{a_w}{W} = \frac{K(1-C)}{W_m C} a_w^2 + \frac{C-2}{W_m C} + \frac{1}{W_mCk} \]  

(3)

Where \( W \) is the equilibrium moisture content, \( W_m \) is the moisture content equivalent to monolayer value and \( C \) and \( k \) are the constants.

Sawhney & Cheryan (1988) applied the B.E.T. equation to moisture sorption isotherm of khoa and found an excellent fit in the water activity range 0.11 to 0.43. The \( X_m \) and \( C \) values of khoa have been found to be 2.978 g water/100 g solids and -29.2 respectively at 25oC. Sawhney et al., (1989) evaluated various models for describing moisture sorption in khoa and reported that the data for khoa fits well to G.A.B. expression up to a water activity of 0.9. The G.A.B. parameter for khoa have been found to be \( W_m \), 3.419; \( k \), 0.84; and \( C \), - 74.05 at 25oC.

5.0 Temperature Dependence of Isotherm Parameters

The knowledge of the temperature dependence of sorption phenomenon provides the valuable information about the changes related to the energetic of the system. The constants in MSI equations, which represent either temperature or a function of temperature, are used
to calculate the temperature dependence of water activity. The Clausius-Clapeyron equation is often used to predict water activity at any temperature if the isosteric heat water activity values at one temperature are known. The variation in water activity with temperature could thus be predicted by incorporating temperature terms into sorption equation. Sawhney et al.,(1991) determined temperature dependence of G.A.B. constant of khoa by drawing up isotherms of the product at 15, 25,35 and 45°C in the following form:

\[ W_m(T) = 0.0306 \exp(11.561 \times 10^3 / RT) \]  (4)

\[ C(T) = 0.172 \exp(15.54 \times 10^3 / RT) \]  (5)

\[ K(T) = 2.9669 \exp(-3.062 \times 10^3 / RT) \]  (6)

The equations (4)-(6) together, with equation (3) can be used to calculate the equilibrium water content \( W(T) \) of khoa at any given water activity and temperature by means of GAB(T) constants.

A survey of literature data on the effect of temperature on different food products shows that the monolayer moisture content decreases with increasing temperature. The extent of decrease, however, depends upon the nature of foods, in khoa, the monolayer moisture content values (in GAB equation) decreased from 3.89 at 15°C to 2.46 g water/100 g solids at 45°C. This relative effect of temperature on monolayer moisture content is important in dehydration shelf life simulation and storage studies.

### 6.0 Water Activity and Reaction Kinetics of Food Deterioration

The primary reactions which affect food quality and stability include, autoxidation fatty acid hydrolysis, oxidation, enzyme reactions, non enzymatic browning and microbiological proliferation. The rate of deterioration of a food can be represented by a simple zero or first order reaction of the following form (Labuza, 1980)

\[ \frac{dA}{d\theta} = k_o e^{\frac{E_a}{RT} \left( \frac{1}{A} \right)^N} \]  (7)

where:

- \( (A) \) = amount of quality factor
- \( \pm dA / d\theta \) = rate of loss of quality factor for production of undesirable effects
- \( k_o \) = pre-exponential factor
- \( E_a \) = activation energy (cal/mole)
- \( R \) = gas constant (cal / mole °K)
- \( N \) = reaction order
The water content and water activity of foods influence $k_o$, $E_a$, (A) and n. At the monolayer moisture content the water is tightly bound and can not act as aqueous phase reaction medium. The rate of reaction is so slow as to be negligible in terms of food storage stability. Just above the monolayer, the solutes can become mobile but their movement is slow. As the water activity further increases the phase viscosity decreases and a rapid mobilization is evident. These factors influence the $k_o$ and $E_a$ by increasing or decreasing them. Another major effect of water activity on reaction rate could be the change in order of reaction. The influence of water activity on a particular quality index of the food product needs to be evaluated individually as well as synergistically. The relationship between stability based on summation of the series of independent and / or interdependent chemical reactions the characterized to work out the water activity optima for a desired keeping quality of the food product.

7.0 Shelf Life Concerns of Moisture Sensitive Milk Products

The shelf life of a product is affected by many factors, including the product itself, packaging design and properties, storage conditions, etc. Knowing all those factors make it possible to predict the shelf life of a product. It has long been recognized that the water activity correlates sufficiently with many deteriorative reactions in the food product. Such as oxidation, enzymatic hydrolysis, maillard reaction, vitamin loss etc. This makes water activity a useful indicator of product stability and microbial activity.

Information derived from moisture sorption isotherm is useful to predict the chemical and physical stability of food as a function of moisture content of the product. A relationship is to be worked out between the moisture content and the target quality parameter for the moisture sensitive food. The target quality parameter could be crispiness of moisture sensitive food or the vitamin loss in the fruit product. The shelf life then can be studied by monitoring the change of moisture content of the food product.

8.0 Critical Moisture Content

Critical moisture content is very important factor for moisture sensitive food product such as milk cereals, milk powders, gulab jamun mix powder, khoa powder etc. Different food products have different critical moisture content. We can determine the critical moisture content in different ways. It could be based on sensory evaluation, which may base on perceived taste, flavour or mouth feel or the result of market search. Ant specific chemical reaction, such as browning or lipid oxidation could also be the critical parameter for critical moisture content. The critical moisture content is to be correlated with these deteriorative indices. Determination of critical moisture content makes it possible to calculate the shelf life of moisture sensitive food product.

9.0 Predicting the Shelf Life of Moisture Sensitive Milk Product

There is no universal simulation model for all food products to study their shelf life. Each product has its own unique characteristics in terms of both physical and chemical properties and stability. to establish shelf life prediction equation for a given food product it is required to study and correlate the unique product properties with environmental
conditions and the package characteristics. It is complicated to stimulate the real shelf life situations. To simplify the stimulation some assumptions are always made to make prediction of shelf life easier and workable.

The process of predicting the shelf life of a moisture sensitive food product can be delineated below:

- Study the properties of moisture sensitive food product, such as initial and critical moisture content and moisture sorption isotherm.
- Decide the critical deteriorative indices and establish their dependence on the environmental conditions.
- Characterize the mass transfer properties of packaging material and their dependence on the environmental conditions.
- Develop the predictive equation describing the storage condition and time-dependent change in the predominant attribute of the food product.
- Integrate the predictive equation for package properties with the predictive equation for product and establish the product–package–environmental interaction equations.
- In-package shelf life measurement of the food product experimentally.
- Compare the validity and stability of developed predictive model.

10.0 Water Activity Adjustment in Traditional Milk Products for Shelf Life Enhancement

Control of moisture in processing of foods is an established method of preservation. It is now well accepted that the shelf life of foods can be extended considerably by adjusting the water activity to below 0.85 (Leistner, 1976). Humectants such as salt, sugars, glycerol and propylene glycol can be added to the food system to develop more favorable water sorption isotherms (Karel, 1976). In addition to their ability to bind water, some humectants also exhibit other desirable effects in food system as a result of their antimicrobial properties, sweetening capacity and texturizing characteristics (Labuza et al., 1974). Humectants that reduce the water activity of food without adversely affecting their taste and rheology, greatly improve the marketability of the foods by extending their shelf life.

Modification of water activity of heat concentrated whole milk product ‘khoa’ with addition of humectants has been attempted by Sawhney et al., (1992). The water activity of freshly made khoa is 0.96. (Sawhney and Cheryan, 1988) which is optimal for growth of most of bacteria and mold. The water activity of khoa could be reduced to 0.846 by addition of 30% sucrose (Sawhney et al., 1992), 0.91 by addition of 4% glycerol (Sawhney et al., 1994) and 0.931 by addition of 4% propylene glycol (Sawhney et al., 1990). Synergistic effect of different combinations of various humectants was studied by Sawhney et al., (1997) to evaluate the sorption characteristics, product acceptability and stability in terms of rheological characteristics, microbiological growth rate and sensory evaluation. The samples adjusted to 0.866 water activities with a humectants combination of sucrose, starch and glycerol have been reported as most acceptable and stable. In addition to the lowering of water activity by using humectants, the shelf stability of the food product could further be
enhanced by using other additives in conjunction with the humectants provided the regulatory and safety aspects are satisfied.

11.0  Suggested Readings


1.0 Introduction

A food can be regarded as ‘functional’ if it affects beneficially one or more target functions in the body, beyond providing basic nutrition, in a way that improves health and well-being or reduces the risk of disease. The market of functional foods is growing rapidly worldwide. Functional foods are also known as nutraceuticals, designer foods, medicinal foods, therapeutic foods, super foods, foodceuticals, and medifoods. Central to the development of such foods has been the growing application of probiotic microorganisms that reside in the intestinal tract and are frequently associated with health-promoting attributes. Such microbial preparations have been called “probiotics” and were recently described as “living microorganisms, which upon ingestion in certain numbers, exert health benefits beyond inherent basic nutrition”.

2.0 Probiotic Dahi

Dairy products offer protection to the incorporated beneficial microorganisms during gastric passage, hence are useful vehicles for the delivery of probiotic microorganisms. The lactobacilli (Lactobacillus and Bifidobacterium spp.) are important inhabitants of the intestinal tract of men and animals and are involved in a number of potential health beneficial roles viz., immunomodulation, pathogen exclusion, production of antimicrobial substances, anticarcinogenic and cholesterol lowering activities.

Several studies in our laboratory and elsewhere have demonstrated the potential of Lactobacillus acidophilus (Lb. acidophilus) and Bifidobacterium bifidum (B. bifidum) to reduce serum cholesterol level. Dietary supplementation with Lb. acidophilus has been reported to delay the development of colon cancer in rats exposed to 1,2 dimethylhydrazine (DMH). Antitumor activity of B. infantis has been demonstrated in balb / c mice.

Studies from our laboratory have demonstrated immunomodulatory attributes of dahi in mice. Dahi stimulated non-specific immune response by activating macrophage activity and humoral immune system in mice challenged with Shigella dysenteriae (Sh. dysenteriae). There was decreased colonization of liver and spleen with Shigellae in mice fed with dahi and than challenged with S. dysenteriae.

Opportunities are now abound for incorporation of lactobacilli into functional foods, dietary adjuncts and health related products. Fermented milks have been an important and highly valued component of man’s diet. The ‘halo of health’ built around yogurt by scientists and manufacturers, is the main reason for its stupendous success in the west, particularly
during the 1990s. Yogurt is traditionally manufactured using thermophilic lactic acid bacteria (Streptococcus thermophilus and Lactobacillus delbrueckii ssp. bulgaricus). The incorporation of beneficial intestinal microorganisms, viz., Lb. acidophilus and Bifidobacterium species into yogurt has been an area of great interest in the western world.

Oral probiotics must contain at least 1 x 10^5 viable cells per gram or per ml of final product at the time of consumption, and an intake of at least 300-400 grams of product per week is necessary for any beneficial effect to develop. Therefore, apart from properties related to the beneficial effect, criteria for the selection of probiotic strains for incorporation into cultured dairy products include multiplication in milk, interaction with lactic starter organisms and survival during storage. Cultured dairy products with enhanced probiotic attributes could go a long way in improving the health status of our society. People in the Indian subcontinent have been largely deprived of the benefits that came from the consumption of probiotic products, because yogurt is not well received here and information on the use of popular indigenous fermented milk as carriers of probiotic microorganisms is lacking.

Mesophilic lactic acid bacteria (mainly Lactococcus species) are used in the manufacture of dahi, lassi and cultured buttermilk. Neither do these organisms inhabit the intestinal tract of humans and animals, nor do they survive gastric passage in large numbers. Dahi happens to be a widely popular item of daily diet in India. Thus, it could be exploited as a vehicle for delivering probiotic bacteria such as Lb. acidophilus and Bifidobacterium species to the Indian consumers. We have prepared a buffalo milk based probiotic dahi by co-culturing the selected strains of Lb. acidophilus and Bifidobacterium bifidum and mixed mesophilic dahi culture (Lc. lactis ssp. cremoris and Lc. lactis ssp. lactis biovar. diacetylactis) and evaluated the product in animal model for health benefits such as ability to reduce risk of colon cancer, atherosclerosis and stimulation of body immune system and antioxidant status.

2.1 Gastrointestinal carcinogenesis

Intervention of cultured milks (dahi or probiotic dahi) on gastrointestinal (GI) carcinogenesis was studied in 21 d old male albino rats fed for 33 weeks. Carcinogenesis was induced by dimethylhydrazine dihydrochloride (DMH) injected (s.c.) weekly for 20 wk starting 4 wk past start of feeding.

- The incidence of tumors in GI tract was fewer on probiotic dahi (60%) than on dahi (73%) and milk (85%).
- Tumor multiplicity and tumor volume were less on probiotic dahi than on milk and dahi.
- Accumulation of thiobarbituric acid reactive substances (TARS), a measure of tissue lipid peroxidation, in colorectal tissue was significantly lower on probiotic dahi compared with other two dietary groups (milk or dahi).
- The activity of glutathione-S-transferase, a measure of carcinogen detoxification, in liver was almost double on probiotic dahi than on milk and dahi.
- Faecal β-glucuronidase activity, a measure of carcinogen activation diminished significantly on probiotic dahi.
2.2 Lipid profile

Intervention of fermented milks (dahi or probiotic dahi) on lipid profile was studied in male albino rats (110 d old) fed hypercholesterolaemic diet for 110 days.

- Mean body weights of animals were comparable in all the three dietary groups.
- Plasma total cholesterol on hypercholesterolaemic diet increased in all the three dietary groups and the rise was minimal on probiotic dahi (58.6 mg/dl), compared to dahi (71.7 mg/dl) and milk (69.3 mg/dl).
- HDL-cholesterol increased in all the three dietary groups and the rise was maximal on probiotic dahi (142%).
- The level of LDL + VLDL-cholesterol increased on milk or dahi but not on probiotic dahi. The level of LDL + VLDL-cholesterol at the conclusion of experimental trial was significantly lower on probiotic dahi (28.3 mg/dl) than on milk (57.8 mg/dl) and dahi (52.3 mg/dl).
- The rise in plasma total cholesterol on probiotic dahi was due entirely to rise in HDL-cholesterol, while on milk or dahi VLDL + LDL-cholesterol contributed to 53 and 71% rise in cholesterol levels, respectively.
- The magnitude of rise in plasma triglycerides on probiotic dahi was 48% compared to 313% on milk and 202% on dahi.
- Atherogenic index (VLDL + LDL-cholesterol / HDL-cholesterol) decreased by 64% on probiotic dahi.
- The accumulation of cholesterol and triglycerides in liver on fermented milks were significantly lower than on milk, and probiotic dahi was more effective in reducing the accumulation of these molecules.

2.3 Antioxidative status

Intervention of fermented milks (dahi or probiotic dahi) on antioxidant status was studied in male albino rats (110 d old) fed for 110 days.

- Superoxide dismutase (SOD) activity in RBC measured at different time intervals rose significantly on probiotic dahi but not on dahi or milk.
- Catalase activity in RBC increased significantly on both dahi and probiotic dahi, and the later was more efficacious.
- Hepatic SOD activity was stimulated by probiotic dahi but not by dahi, while in colorectal tissue both dahi and probiotic dahi were effective in stimulating SOD activity.
- Both dahi and probiotic dahi were effective in stimulating catalase activity in liver and colorectal tissue.
- The faecal counts of *Lb. acidophilus*, *B. bifidum* and total aerobes in three dietary groups were in the increasing order, whereas coliform counts were in the decreasing order of probiotic dahi, dahi and milk.

2.4 Macrophage activity

Intervention of dahi / probiotic dahi on stimulation of macrophage activity was evaluated in male albino mice weighing 38 to 40 g fed for 2, 5 or 8 d.
The dairy products augmented release of macrophage hydrolytic activities (β-glucuronidase and β-galactosidase) during the initial period of product supplementation. Probiotic dahi was more efficacious than dahi or milk and its effect sustained for longer duration.

Macrophages on probiotic dahi exhibited greater phagocytic activity (percent phagocytosis as well as phagocytic index) throughout the study than on milk or dahi. On dahi, the phagocytic activity of macrophages peaked following 2 d of feeding which then declined gradually and reached close to 0 d level after 8 d of feeding, while on milk it remain unaltered.

### 2.5 Protection against enteric infection

The protective effect against *Sh. dysenteriae* was studied in mice fed dahi / probiotic dahi (5 g/d/mouse) for 2 and 7 consecutive days and then challenged with *Sh. dysenteriae* (5 x 10⁸ cells). The response was evaluated in terms of anti-*Shigella* antibodies in the intestinal fluid and colonization of pathogen in liver, spleen and intestinal tissue.

- Feeding cultured milks (dahi or probiotic dahi) decreased the colonization of *Shigellae* in liver, spleen and intestinal tissue, and these products were more effective during initial period of product supplementation.
- Both dahi and probiotic dahi were almost equally effective in decreasing colonizations of *Shigellae* in liver, spleen and intestinal tissue.
- The levels of anti-*Sh. dysenteriae* antibodies in the intestinal lumen were greater on fermented milks than on milk during the entire post-challenge periods in both 2 and 7 d feeding protocols. probiotic dahi was more effective than dahi in augmenting secretions of anti-pathogen antibodies.

### 3.0 Conclusions

- Probiotic dahi attenuated gastrointestinal carcinogenesis induced by DMH. Increased activity of glutathione-S-transferase and decreased lipid peroxidation and faecal β-glucuronidase correlated with decreased tumor incidence, tumor multiplicity and tumor volume.
- Probiotic dahi attenuated diet induced hypercholesterolaemia and deposition of cholesterol and triglycerides in liver.
- Both dahi and probiotic dahi improved antioxidant status (superoxide dismutase and catalase activities in RBC, liver and colorectal tissue), and probiotic dahi was more efficacious.
- Both dahi and probiotic dahi improved body immune system by stimulating macrophage activity and preventing pathogen colonization in liver, spleen and intestinal tissue; probiotic dahi was effective than dahi in augmenting body immune system.
1.0 Introduction

The food industry is under continuous consumer pressure to produce fresh, unprocessed (or minimally processed) natural, healthy, and safe foods. Preservatives such as nitrites and propionates are either no longer used or are added at very low concentrations. Sterilization and pasteurization also prevents food spoilage but employ heating of the food product. Thus, there is a need for a novel food preservative, which should originate from a natural source and deliver its antimicrobial activity without being labeled as chemical preservative.

Most microorganisms are capable of producing a large variety of molecules. These molecules may be inhibitory either to the producing cell or to other bacteria and include organic acids, toxins, lytic enzymes, antibiotics, bacteriocins, etc. Lactic acid bacteria (LAB) play an essential role in the majority of food fermentations, and a wide variety of strains are routinely employed as starter cultures in the manufacture of dairy, meat, and vegetable and bakery products. One of the most important contributions of these microorganisms is the extended shelf life of the fermented product by comparison to that of the raw substrate. Growth of spoilage and pathogenic bacteria in these foods is inhibited due to competition for nutrients and the presence of starter-derived inhibitors such as lactic acid, hydrogen peroxide and bacteriocins.

2.0 Bacteriocins

Bacteriocins are ribosomally synthesized polypeptides possessing bactericidal activity that are rapidly digested by proteases in the human digestive tract. Bacteriocins differ from most therapeutic antibiotics in being proteinaceous and generally possess a narrow specificity of action (Tagg et al., 1976). A large number of bacteriocins have been isolated and characterized from lactic acid bacteria and some have acquired a status of potent antimicrobial agents because of their potential as food preservatives and antagonistic effect against important pathogens.

Lactic Acid Bacteria (LAB) and their metabolites have been consumed in high quantities by countless generations of people in cultured foods with no adverse effects. So LAB continue as the preferred source of bacteriocins for use in foods, either in the form of purified compounds or growth extracts. The important bacteriocins are nisin, diplococcin, pediocin, acidophilin, bulgaricin, helveticins, lactacins and plantaricins (Nettles and Barefoot, 1993). To date, the only commercially produced bacteriocins are nisin (or group N
inhibitory substance); produced by Lactococcus lactis, and pediocin PA-1, produced by Pediococcus acidilactici, are marketed as Nisaplin™ and ALTA™ respectively. Recently, we have produced a highly potent bacteriocin Pediocin 34 from a pediococcal strain Pediococcus pentosaceus 34 isolated from Cheddar cheese.

2.1 Nisin

Nisin is produced by certain strains of lactic acid bacterium - Lactococcus lactis that functions by interacting with the phospholipids in the cytoplasmic membrane of bacteria, thus disrupting membrane function. Nisin is used in over 48 countries, has Food and Drug Administration approval and Nisaplin™ is sold as a natural food protectant. Nisin has been shown to be effective in a number of food systems, inhibiting the growth of a wide range of Gram-positive bacteria, including many important food borne pathogens such as Listeria monocytogenes (Tagg et al., 1976). It is used predominantly in canned foods and dairy products and is especially effective when utilized in the production of processed cheese and cheese spreads where it protects against heat-resistant sporeforming organisms such as those belonging to the genera Bacillus and Clostridium. This has particular significance in the case of preventing contamination with Clostridium botulinum as there can be serious repercussions resulting from toxin formation by this species. With spores, nisin prevents outgrowth by inhibiting the swelling process of germination (Morris et al., 1984).

The safety and efficacy of nisin as a food preservative have resulted in its widespread use throughout the world, including the U.S. It is highly active against many of the Gram-positive bacteria and especially used by the cheese industry to control growth of Clostridium spp. (Branby-Smith, 1992). Examples of international food products that legally can be amended with nisin are canned soups (Australia), ice for storing fresh fish (Bulgaria), baby foods, baked goods and mayonnaise (Czech Republic), and milk shakes (Spain); however, the majority of approved product types are dairy products (especially cheeses) and canned goods.

2.2 Pediocin

Pediocin is produced by Pediococcus acidilactici, Generally Recognized As Safe (GRAS) organism and commonly found and used in fermented sausage production. Most pediocins are thermostable proteins and function under a wide range of pHs (Rodriguez et al., 2002). Pediocin AcH has been proven to be effective against both spoilage and pathogenic organisms, including L. monocytogenes, Enterococcus faecalis, Staphylococcus aureus, and Clostridium perfringens (Bhunia et al., 1988). A natural antimicrobial called Inovapure is said to be effective against a wide range of food spoilage organisms and can be successfully used to extend the shelf life of various food products, including raw and processed meats, cheese, and other dairy products.

Lacticin 3147 has also been produced and tested as a bio-preservative. A bacteriocin producing strain, Lc. lactis DPC3147, was used to ferment reconstituted demineralised whey (10% solids), which was pasteurized, concentrated and spray dried to produce a bioactive lacticin 3147 powder (Morgan et al., 1999). This powder was subsequently found to be effective in inhibiting L. monocytogenes Scott A and Bacillus cereus in natural yoghurt,
cottage cheese and soup showing the potential of lacticin 3147 as an aid to eliminate pathogenic organisms.

Recently, a food-grade strain has been developed to produce both lacticin 3147 and lacticin 481. This strain addresses both the food safety and food improvement aspects of bacteriocin production. Significantly, the killing effect of this double producer was more pronounced, when tested against *Lb. fermentum* and *L. monocytogenes*, than either bacteriocin producer alone (O’Sullivan et al., 2003). The use of strains that produce multiple bacteriocins could be advantageous to limit the potential emergence of bacteriocin-resistant populations.

### 2.3 Microgard

Microgard products are bacteriocins-like inhibitory substances produced by fermenting grade A skim milk with lactic acid bacteria (such as *Propionibacterium* spp. or *Lactococci* spp.). It has been approved by FDA and widely used as a biopreservative for more than a decade by the U.S. cottage cheese industry (Daeschel, 1989). Microgard is shown to be antagonistic toward most gram-negative bacteria and some yeasts and molds, but not against Gram-positive bacteria. Microgard products are not very effective against *E. coli* O157:H7 and *L. monocytogens* in a meat system when used alone (Sharma et al., 2001). However, a combination of other techniques, such as irradiation or ozonation processing along with Microgard, may provide a synergistic effect to make our food safe.

### 3.0 Biopreservation of Traditional Dairy Foods

Milk in its natural state is highly perishable material because it is susceptible to rapid spoilage by the action of naturally occurring enzymes and contaminating microorganisms. Many processes have been developed over the years in particular during the last century for preserving milk for long periods and to enhance its utilization and safety. Milk is converted into a wide variety of milk products using a range of advanced processing technologies. These include not only traditional dairy products, such as a variety of cheeses, yoghurts, butters and spreads, ice cream and dairy desserts, but also new dairy products containing reduced fat content and health-promoting components. Although 46 per cent of the milk produced in the country is consumed as liquid milk, an estimated 50 to 55 per cent of the milk produced in India is converted into a variety of traditional milk products. Over the millennia, traditional milk products of India have enriched the cuisine of this vast subcontinent.

The term ‘traditional dairy foods’ refers exclusively to dairy products of a particular region or country. Products like dahi, makkhan, lassi and ghee are placed at the top of the list of traditional foods and others are srikhand, gulab jamun, burfi, peda, paneer etc. Traditional foods are highly accepted because of their delicious flavour, taste and nutrition. They are essentially based on the locally/regionally available raw materials and the know-how evolved and standardized over centuries. But they are facing extinction since the emerging generations are losing track of the techniques of preparation and preservation of these valuable products. Fortunately, today ethnic foods seem to be gaining grounds by cutting across barriers of regions/cultures.
3.1 Microbiological quality of traditional dairy products

All traditional dairy foods like Khoa, channa, paneer, kheer, dahi and others serve as favorable medium for the growth of a variety of micro-organisms because of high moisture content and good nutritive value. The market khoa usually keeps well for 48 hr under usual conditions of handling and storage. However storage beyond this period often results into deterioration due to microbial action. Various types of bacteria (acid producers, proteolytic, chromogenic, lipolytic, aerobic spore-formers, psychrotrophs, thermophiles, and pathogens), yeasts and molds have been reported to occur in khoa. Psychrotrophic bacteria mainly, *Pseudomonas, Achromobacter, Flavobacterium* and *Alcaligenes* have been isolated from heat dessicated khoa based proucts. Contamination of these products with *Salmonella typhi, Shigella dysenteriae, Shigella flexneri, Vibrio cholera*, and *E. coli* has been reported to be correlated with faecal contamination. Khoa based sweets such as gulabjamun, kalakand, burfi, Milkcake are found to be contaminated with thermophiles, mesophiles, yeasts and molds. *Gulabjamun* is safer from microbiological point of view because it is soaked in sugar syrup. *Rabri* and *khurchan* are more susceptible to spoilage by heat resistant spore-formers. *Mucor, Pencillium, Aspergillus* and *Rhizopus* are also encountered in these products as post contaminants. In *kulfi* and other related frozen products, *Staphylococcus* and coliforms form the predominant organisms appearing from various additives, dust or uncleaned containers. Most commonly occurring molds in chhana belong to genera *Penicillium, Aspergillus, Mucor, Rhizopus, Fusarium* etc.

3.2 Bacteriocins as Biopreservatives

With the present growth rate of the global population and the increasing rate of urbanization, one of the most important issues for all the governments of the world will be to know how to organize and maintain safe and secure food supply at a reasonable price to all its growing number of households. Fermentation is known to be a technology of choice for food preservation since ancient times. It is also well-recognized for its health promoting properties. South Asian countries and India in particular, have a bountiful heritage of traditional fermented foods, including fermented milks, cheeses, fermented cereals, legumes, vegetables, fruits, meats, etc.

Bacteriocins have often been mooted as potentially valuable biological tools to improve the food safety and reduce the prevalence of food borne illnesses. There already exist many control measures within the food industry to prevent or minimize bacterial contamination, including good manufacturing practices, effective sanitation and hygiene measures with respect to raw materials, the food plant, the food products, the food processing personnel and other basic fundamentals of an effective Hazard Analysis Critical Control Point (HACCP) programme. These measures facilitate the identification, evaluation and control of food safety hazards (National Advisory Committee on Microbiological Criteria for Foods (NACMCF), 1998). However, despite these precautions, food borne outbreaks do occur alarmingly frequently. *L. monocytogenes* is not the only concern; there exists a substantial list of food pathogens that result in foodborne illnesses every year, including many Gram-negative pathogens such as *Escherichia coli* VTEC 0157, *Campylobacter* and *Salmonella* (Adak et al., 2002). Although the nature of the Gram-negative cell wall restricts
the activity of LAB bacteriocins, bacteriocins may be used in combination with other treatments, such as high hydrostatic pressure (HHP), to increase their effectiveness. Thus, bacteriocins may be best applied when providing an extra obstacle to prevent the growth of pathogenic and spoilage bacteria, especially in situations where contamination could occur post-production.

There are at least three ways, in which bacteriocins can be incorporated into a food to improve its safety i.e,

- using a purified/semi-purified bacteriocin preparation as an ingredient in food,
- by incorporating an ingredient previously fermented with a bacteriocin-producing strain, or
- by using a bacteriocin-producing culture to replace all or part of a starter culture in fermented foods to produce the bacteriocin in situ.

Among the various methods of preservation of traditional dairy foods like hot packaging, drying, addition of chemical preservatives, UV-irradiation, low temperature storage, and addition of sugar. Biopreservation with microbial metabolite nisin, a bacteriocin, produced by Lactococcus lactis, has also been found to be effective in controlling the spoilage organisms. Incorporation of nisin in the product enhanced the shelf-life of khoa by more than 30 days, 3 weeks, and 2 weeks during storage at 10°C, 22°C and 30°C, respectively.

Pediocin 34 produced by a Pediococcus pentosaceus 34 has been shown to significantly enhance the shelf-life of Paneer. Similarly, shelf-life of Khoa was increased upto more than 35 days at refrigeration temperature by the addition of bacteriocin (2000 AU/g). Thus, it may serve to enhance the shelf-life of several foods in combination with other hurdles.

### 3.3 Antifungal Activity of Bacteriocins

Besides the reports on antibacterial activity of proteinaceous compounds produced by LAB, there few reports which suggests the antifungal activity of LAB’s proteinaceous compounds. De Muyncj (2004) assessed the potential of 17 lactic acid bacteria to inhibit the outgrowth of some common food-spoilage fungi. Thirteen strains showed antifungal activity of which five strains were very promising: Lactobacillus acidophilus LMG 9433, L. amylovorus DSM 20532, L. brevis LMG 6906, L. coryniformis subsp. coryniformis LMG 9196 and L. plantarum LMG 6907.

Durlu-Ozkaya et al., (2005) isolated and identified yeasts from some cheeses and reported the antifungal activities of some Lactobacillus spp. against the isolated yeasts, ten belonging to Saccharomyces cerevisiae and one each of Candida pseudotropicalis, C. krusei, C. lipsylocitlea, C. lusitaniae, C. ciferrii, Torulopsis glabrata and Rhodotorula rubra. Of all the test culture, L. plantarum Lp 21 had the maximum inhibitory effect against all the S. cerevisiae strains.


4.0 Hurdle Technology

The major functional limitations for the application of bacteriocins in foods are their relatively narrow activity spectra and moderate antibacterial effects. Moreover, they are generally not active against Gram-negative bacteria. To overcome these limitations, more and more researchers use the concept of hurdle technology to improve shelf-life and enhance food safety. It is well documented that Gram-negative bacteria become sensitive to bacteriocins if the permeability barrier properties of their outer membrane are impaired. For example, chelating agents, such as EDTA, can bind magnesium ions from the lipopolysaccharide layer and disrupt the outer membrane of Gram-negative bacteria, thus allowing nisin and other bacteriocins to gain access to the cytoplasmic membrane (Abee et al., 1995). It is frequently observed that bacteriocins, in combination with these processing techniques, enhance bacterial inactivation. In addition, Gram-negative bacteria, such as E. coli O157: H7 and S. typhimurium, that are usually insensitive to LAB bacteriocins, become sensitive following HP/PEF treatments that induce sublethal injury to bacterial cells (Kalchayanand et al., 1994).

Several researchers have also examined the synergistic action of nisin and other antibacterial products/processes on various microorganisms—nisin and sodium lactate (Nykanen et al., 2000), nisin and sodium chloride (Pawar et al., 2000), nisin and carvacrol (Pol and Smid, 1999), and Sorbate and nisin (Avery and Buncic, 1997).

Incorporation of bacteriocins into packaging films to control food spoilage and pathogenic organisms has been an area of active research for the last decade. Antimicrobial packaging film prevents microbial growth on food surface by direct contact of the package with the surface of foods, such as meats and cheese. Coating of solutions containing nisin, citric acid, EDTA, and Tween 80 onto polyvinyl chloride, linear low density polyethylene, and nylon films reduced the counts of Salmonella typhimurium in fresh broiler drumstick skin by 0.4- to 2.1-log10 cycles after incubation at 4 °C for 24 h (Natrajan and Sheldon, 2000). This incorporation of bacteriocins in packaging films can also be helpful in the preservation of tradition dairy foods that could check the post processing contamination of foods.

5.0 Biopreservation of global traditional dairy products

L. monocytogenes has been the well documented cause of a number of outbreaks associated with dairy products, such as pasteurized milk and cheese. However, nisin, pediocin 34 and a few more bacteriocins have been shown to be effective against L. monocytogenes in dairy products. Addition of nisin (100 IU/ml) has been found to be effective in inhibiting the growth of L. monocytogenes for a period of 8 weeks or more. Zottola et al., (1994) used nisin-containing Cheddar cheese that had been made with nisin-producing lactococci as an ingredient in pasteurized process cheese or cold pack cheese spreads. The shelf-life of this nisin-containing pasteurized process cheese (301 and 387 IU Nisin/g) was significantly greater than that of the control cheese spreads. In cold pack cheese spreads, nisin (100 and 300 IU/g) significantly reduced the numbers of L. monocytogenes, S. aureus, and heat-shocked spores of C. sporogenes. Another problem in cheese production is the Clostridium-associated butyric acid fermentation. Nisin is commonly added to pasteurize
processed cheese spreads to prevent the outgrowth of clostridia spores, such as *Clostridium tyrobutyricum* (Schillinger *et al.*, 1996). One application of lacticin 3147, a broad-spectrum, bacteriocin produced by *L. lactis subsp. lactis* DPC 3147, reduced non-starter LAB populations during Cheddar cheese ripening (Ross *et al.*, 1999).

Artisanal cheeses are made from cows’, goats’ and buffalo’s milk by farmers and shepherds on small scale relying solely on the lactic acid bacteria naturally present in milk. The quality of such cheeses depends to a great extent on the composition of microflora. Inhibitory activity of enterocin producing *E. faecium* and *E. faecalis* strains against *L. monocytogenes* and *S. aureus* has also been well documented in these systems. Yeasts are also very important contaminating flora of dairy products among pathogenic and spoilage microorganisms. They cause spoilage of products and make them unfit for consumption and are responsible for being a public health hazard. Some *Lactobacillus* strains isolated from traditional Turkish cheeses have been found to possess very strong antifungal activity against *S. cerevisae* and such strains can be effectively exploited for the improvement of the shelf life of cheeses (Durlu-Ozkaya *et al.*, 2005).

6.0 Conclusion

Civilization has reaped the benefits of bacteriocins unknowingly for 1000s of years, yet nisin is the only bacteriocin bio-preservative that has received acceptance in countries worldwide. It would be naive to believe that bacteriocins represent the ultimate solution to food safety problems. However, given the effectiveness of bacteriocins, the existence of economically viable means through which they can be incorporated and a consumer desire for minimally processed food, they may represent an excellent alternative for use in combination with other natural preservatives.

Continued research on bacteriocins will undoubtedly lead to our increased understanding, and with the emergence of new bacteriocins, new potential bio-preservatives. However, this potential will only be fulfilled if bacteriocins are appropriately used and marketed successfully.

7.0 Suggested Readings


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DAIRY PRODUCTS: AN AYURVEDIC PERSPECTIVE

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1.0 Introduction

Ancient Ayurvedic texts have accounted milk and its byproducts as the best among all the life-giving substances. The texts have described milk as a complete and ideal food, which contains nearly all the ingredients of a balanced diet.

The following milk/dairy products are described in detail in the Ayurvedic texts – Dugdha (Milk), Santanika (Cream), Takra (Butter milk), Dadhi (Curd), Mastu (Whey), Takra Pinda (Cheese), Ghrit (Clarified butter or ghee), Piyush (Colostrum).

1.1 Dugdha (Milk)

According to Ayurveda, milk provides special and unique nutrition that cannot be derived from any other type of food. Milk, when digested properly, nourishes all the tissues, promotes balanced emotions, and helps to balance all the doshas. It is one of the most important foods to promote ojas. According to Ayurveda, ojas is a refined substance the body produces from the most subtle level of proper digestion and it brings strength, strong immunity, happiness, and contentment. Therefore milk is a very important food to include regularly in one's diet specially if you follow a vegetarian lifestyle.

Ayurveda describes milk as cooling and appetizing, heals wound and fracture, increases semen strength, vitality and mental power. It is assimilable and useful for all, acts as a purifier, effective in acidity, anaemia, diarrhea, relieves paittika and vatika doshas. Ayurveda declares milk to give mass, sweetness and coolness to meal, so it is supposed to be calm and beneficial for nursing mothers. Cows milk is said to be the ideal substitute of the mother’s milk.

According to Ayurveda cows milk is best in the milk category on the basis of its jivaniya (strength promoter) and Oja vardhaka (immune booster) properties. Cow’s milk delays the aging process and is said to be a cure for almost all diseases. The qualities of milk and its byproducts obtained from various sources of different geoclimatic condition and according to color of the skin of the animal are also described in detail.

Milk is widely used in Ayurveda as adjuvant of medicines (as a vehicle), for rasayana (immuno booster) formulations, as a bhawana to detoxify/increase the therapeutic property of the formulations, to increase the palatability of the formulations. It can be used as an ingredient in the formulation/therapy given through nasal route, oral route, for topical application, and is used specially in Panchakarma i.e. Vamana, Virechana and Vasti Yoga.
Ayurvedic literature gives recommendations about the form and the subjects for whom milk is best for consumption, seasons and time when its use should be avoided.

The milk of the following others along with their therapeutic quality and specifications is also suggested for human use – cow, sheep, buffalo, camel, goat, she elephant (cow), mare, mothers milk.

1.2 Navanit (Butter)
It is used in piles, chronic dysentery, anorexia and in facial paralysis. It agrees best with the old and young.

1.3 Takra (Butter Milk)
Ghola, Mathita, Udashvita and Chhachhika are synonyms of Takra. Takra from cow’s milk is tonic, cardiac, stimulant, invigorating, stomachic, effective in emesis, piles, anaemia, obesity and dyspepsia.

The diseases cured with Takra never reoccur and even today some Ayurvedic Physicians do the treatment of different diseased conditions only with the help of Takra (Takra Therapy).

1.4 Dadhi (Curd)
Curd is agreeable, digestive and cooling: it is acid and astringent, relieves Vayu, produces marrow, semen strength and blood, aggravates pitta and Kapha, help digestion and is an appetizer.

1.5 Ghrit (Clarified Butter or ghee)
Ghrit is considered cooling, emollient and stomachic. It increases the fatty tissues and mental power, promotes digestion, improves the voice, beauty, and complexion. If taken in excess, increases Kapha. Ghee is strengthening. It is good for transporting herbal influences to tissues.

The Ghrit is classified in detail on the basis of its seasoning i.e Purana, Prapurana, Kumbhasarpi and Mahasarpi. The formulations prepared with Ghrit are very useful in mental disorders, piles, rhinitis, sinusitis, vision disorders. Ghrit is essential for Snehana, which is a pre Panchakarma operation. Milk and ghrit both are recommended as best antidote for metal/mineral/herbal poisoning.

1.6 Mastu (Whey)
Whey has properties similar to those of curd; in particular it favours the circulation of animal fluids and therefore useful in constipation.
1.0 Introduction

Electron microscopy was applied to dairy research for the first time by Nitschmann (1949) who studied casein micelles in skimmed milk. Since then milk and dairy products have been investigated by this technique rather more extensively and systematically than other human foods. During various technological treatments, the microparticulate constituents i.e. the fat globules, the colloidal casein micelles and the molecular dispersion of whey proteins, undergo significant physical changes and mutual interactions. This gives rise to the characteristic macroscopic structure and physical properties of the products. The ability of casein micelles to interact with whey proteins, to aggregate and hydrolyze under the influence of low pH, high heat and the presence of proteolytic enzymes is crucial for preparation of dairy products. Therefore, electron microscopy of dairy products is extremely useful in elucidating the relationship between macroscopic properties and submicroscopic structure as altered by technological treatments. Traditional Dairy products are either heat desiccated (Khoa, Gulabjamun) or acid coagulated or their derivatives obtained by several process modifications (channa, paneer, rasogolla). The chemical composition of these products including various additives such as sugar and starch and the processes to which they are subjected during processing determine the texture and microstructure of the products. Microstructure in turn, controls some of the attributes of the products such as elasticity, sponginess, brittleness, firmness.

2.0 Electron Microscope As A Tool

The microscope has been conventionally used for the study of both biological and non-biological systems. In biological sciences, it has been employed to study the structure, shape and size of specimens and also to detect contaminants. This amazing analytical tool can be put to use in food sciences beyond these basic applications. It can be used to decipher what happens to the food material such as grains, muscles or milk when they are processed in to a pasta, ham or streak, yoghurt or cheese. Food scientist can ascertain what makes a particular food to be elastic or spreadable (e.g. string cheese & processed cheese) or foods which exhibit smooth texture under normal conditions become gritty (e.g. ice cream stored for long time). The Optical microscope can not only be used to study structural details such as globules or fibers but also to distinguish proteins from fat, starch, cellulose, mineral components and bacteria from bacteria.

Electron microscope provides a markedly higher magnification at a considerable better resolution than light microscope. Electron microscopy takes advantage of the wave nature of rapidly moving electrons. Where visible light has wavelengths from 4,000 to 7,000 Angstroms, electrons accelerated to 10,000 KeV have a wavelength of 0.12 Angstroms.
Optical microscopes have their resolution limited by the diffraction of light to about 1000 diameters magnification. Electron microscopes, so far, are limited to magnifications of around 1,000,000 diameters, primarily because of spherical and chromatic aberrations.

3.0 Types of Electron Microscopy

There are two major electron microscopy modes—Scanning electron microscopy (SEM) and Transmission Electron microscopy (TEM). The electron beam is focused using magnetic lenses in both kinds of microscope. The specimen is placed into the path of the electron beam in the TEM but in the SEM, it is placed at the end of the focused electron beam path. The image is produced in the form of a shadow on a fluorescent screen in TEM whereas in SEM reflected and secondary electrons are processed by an electron detector to form a three-dimensional image on a monitor screen.

Since the electrons would be easily absorbed by air, the microscopic examination is carried out in vacuo. To ensure that the electrons will penetrate a thin section of the specimen or its replica, the electron beam is accelerated in the microscope. An anode with an orifice in its centre is positively charged. The negative electrons rush toward it and those which are in the centre fly, accelerated, through the orifice toward the specimen. Accelerating voltage of 3 to 20 kV has been used to do SEM and 60 to 80 kV have been used in TEM of foods.

Traditional electron microscopy requires that the specimen must not release any gas or vapour when inserted into the transmission or scanning electron microscope. Except for powdered foods such as flour, sugar, or milk powder, most foods contain water. Drying or freezing at a very low temperature of -100°C ensure that the condition of not releasing gas or vapour is met.

3.1 Scanning Electron Microscopy

The conventional method of sample preparation for scanning electron microscopy (SEM) includes chemical fixation (Glutaraldehyde, Osmic Acid), dehydration with a graded series of ethanol or acetone and subsequently drying by air drying, freeze-drying or critical point drying. The specimen is mounted on an aluminium stub and coated with heavy metal to make it electrically conductive. It has been demonstrated that simple air-drying of the specimen yields collapsed micelles even after proper fixation due to the strong interfacial forces created as a result of passage of receding water surfaces over the particles. Better results have been obtained with freeze-drying and critical point drying.

The specimen is examined by a focused electron beam. An electron gun is the source for this beam. Electrons are emitted from a cathode, accelerated by passage through electrical fields and focused to a first optical image of the source. The gun consists of tungsten or lanthanum hexaboride electrode surrounded by a shield with a circular aperture. Electrons in the gun are accelerated across a potential difference of the order of 10,000 volts between the cathode (at high negative potential) and anode (at ground potential). Some of these electrons are reflected and others generate secondary electron from the gold coating. (A great variety of other interactions also take place). Secondary electrons (or, in other applications, backscattered electrons) are used to form an enlarged image of the specimen surface. The
incident electrons carry a negative charge and in order to be 'neutralized' after they have completed the examination, the specimen should be electrically conductive. As mentioned earlier this is achieved either by chemical procedures which impregnate the specimen with osmium or, more frequently, by physically coating its with gold, a gold-palladium, platinum, or iridium - occasionally both procedures are combined. Metal coating provides a path for the electrons. It this path is interrupted (by incomplete metal coating or by cracks), the electrons sit in the area thus isolated and repel any electrons in the incidental beam in accordance with the rule that electrically charged particles of the same charge repel each other. Thus the area occupied by the stationary negative charge is by-passed and cannot be examined. White spots or lines develop in such places and the image is characterized as suffering from *charging artifacts*.

### 3.2 Transmission Electron Microscopy

TEMs are patterned essentially after TLM and yield information on the size, shape and arrangement of particles which make up the specimen as well as their relationship to each other on the scale of atomic diameters. The electromagnetic lenses (first & second) determines the spot size of the electron beam generated by electron gun and also alters the spot to a pinpoint beam. Further condensor lens restricts the beam by knocking out high angles electrons and beam strikes the specimen and parts of it are transmitted. The transmitted portion is focused by the objective lens into an image which is passed down the column through the intermediate and projector lenses, being enlarged all the way.

One of the most widespread techniques of specimen preparation for electron microscopy is thin sectioning of plastic-embedded samples. This technique comprises a fixation, dehydration and finally impregnation in some suitable plastic monomer such as araldite or epon. After hardening thin sections (15 to 90 nm thick) are cut with ultramicrotome and picked up on an electron opaque metal grid of 200-400 mesh (lines/in) to provide mechanical support. Most EM grids are made of copper because it is non-ferromagnetic and thus minimally distorts the magnetic field of the objective lens. Even so, it is usual practice in high resolution studies to avoid recording images of specimens which lie close to the grid bars. The specimens are post stained with heavy metals such as lead citrate and uranyl acetate and placed into the path of electron beam.

### 3.3 Microstructure of Traditional Dairy Products

Electron Microscopy has been employed in a number of studies to observe and characterize the microstructure of Traditional Dairy products viz paneer, chhana, khoa, sweetmeats prepared from them e.g. *rasogolla*, *gulabjamun*, *burfi* and *kalakand*, and fermented milk product e.g. *Dahi*.

#### 3.3.1 Chhana and Paneer

Some cheeses (Indian *Paneer* cheese, South American *Queso Blanco* cheese, American *White* cheese, North American *Ricotta* cheese) are made by coagulating hot milk with an acid and separating the curd from the whey.
These cheeses have several features in common: the milk is first heated to at least 85°C and then is coagulated using an acid such as citric, lactic, acetic, or hydrochloric acid (or an acid precursor such as glucono-d-lactone) to a final pH value of 5.5. This means that the curd is not too acidic. The coagulated milk is then cooled and the whey is separated. The microstructure of the casein particles has a characteristic ‘core-and-shell’ structure (micrograph at left). (The whey contains very little whey proteins since they coagulated due to the heating and became part of the curd).

How the microstructure develops has not yet been fully explained but it is known that three essential conditions must be met: The milk must be coagulated at a temperature higher than 85°C so that whey proteins may interact with the k-casein; Whey proteins and the milk salt system must be present in the milk; The final pH value must be 5.5 ± 0.1 (Kalab et al., 1988).

As revealed by SEM, microstructure of chhana has been found to be coalesced large masses of casein whey protein complexes, interlinked with some thick bridging material interrupted by closely interspersed small voids. Buffalo milk chhana yields structure close to cottage cheese or paneer and is characterized by denser and coarser matrix than that of cow milk chhana (Adhikari, 1992).

### 3.3.2 Rasogolla

Rasogolla has typical microstructure with least resemblance to other dairy products. Cooking severely affects the compactness of Chhana matrix and yields loose porous structure having large void spaces throughout the matrix. Cow milk rasogolla has been reported to be containing thick filamentous structure of agglomerated protein bodies arranged in folds with numerous voids in between whereas densely fused large conglomerates of protein forming layer and scale were found to characterize microstructure of buffalo milk rasogolla. In case of mixed milk rasogolla, both filamentous and scale type protein bodies prevailed in the structure. Rasogolla prepared from lactic acid coagulated chhana have been observed to be more compact and ragged protein matrix to that of rasogolla made from citric acid coagulated chhana (Adhikari, 1992, Munjal, 1993).

### 3.3.3 Khoa

The SEM study of heat induced structural changes taking place during the manufacture of khoa as well as gulabjamun (Adhikari, 1992) revealed that constant boiling of milk during khoa making led to gradual coalescence of the casein whey protein complexes to a fuzzy-agglomerated mass precipitating out as large interlinked gritty particles. Further heating effected the compaction of protein lactose complexes and Buffalo milk khoa exhibited more open structure than that of cow milk one while mixed milk khoa was slightly denser to that of buffalo milk product.

### 3.3.4 Gulabjamun

Frying of khoa led to a different structural manifestation in gulabjamun. The compact protein bodies of khoa turned to a loose matrix and the starch and associated particles
interspersed loosely among them. Cow and mixed milk *gulabjamun* had comparatively denser matrix to that of buffalo milk *gulabjamun*. A comparison of microstructure of market and laboratory made *gulabjamun* revealed thread or net type structure and rosette structure respectively (Adhikari, 1992).

### 3.3.5 Kalakand and Burfi

The SEM studies (Narendra, 2006) of fresh *kalakand* with sucrose (control) and *kalakand* sweetened with saccharin, showed that resulting microstructure of control was a spongy 3-D structure due to a networking of casein micelles alternating with very small pockets. *Kalakand* manufactured using saccharin lacked a well defined 3-D microstructure. The microstructure of protein matrix differs from the matrix in control. The spongy texture was replaced with a loosely held structure with fewer pockets of larger size as compared to control. Hence, it is clearly evident that sucrose is responsible for maintaining the structure of *kalakand* (control) due to its water binding ability and thus providing enhanced stability. This property is lost in *kalakand* manufactured using alternative sweetener saccharin.

A similar pattern in the formation of microstructure was evident in control and *burfi* made with saccharin. The control *burfi* had a well defined compact globular structure while replacement of sucrose with saccharin resulted in development of microstructure which had lost most of its globular nature. The microstructure appeared to be open or loosely held. This difference can be ascribed to the presence of sugar in the control samples.

The compactness of the network decreased with the use of alternate sugar (saccharin). The loose network in these samples may explain the low hardness, cohesiveness and accordingly gumminess and chewiness in these samples. Hence, each of the two systems resulted in a distinct type of microstructure in the finished product i.e. *burfi* and *kalakand*.

### 3.3.6 Dahi

A microstructural comparison (Gupta *et al.*, 2000) of market sample and laboratory made *mishti Doi* revealed that former had ill defined microstructure with yeasts present as contaminants while the latter was shown to have a clear protein matrix with uniform distribution of lactic acid bacteria. The casein micelles were fused together, formed chains and clusters to entrap whey and lactic cultures. The use of starch as stabilizer results into rather stratified matrix without any discernible micro structural details suggesting interaction between starch and casein micelles (Roy, 1992).

### 4.0 Suggested Readings


TECHNOLOGIES FOR READY-TO-RECONSTITUTE TRADITIONAL MILK DESSERTS

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1.0 Introduction

In India nearly 56 per cent of the milk produced is available as marketable surplus for urban areas and a fairly large proportion of it is converted into traditional milk products. The share of the organized dairy sector in traditional products is very small. While the Government/co-operative sector markets nearly 80 per cent of the milk as liquid milk, the private sector markets only 30 per cent as liquid milk, and the remaining 70 per cent as milk products mostly comprising powder, butter and ghee. The future for commodities like powder and ghee does not appear sustainable and hence a major shift in product mix for organized dairy industry seems inevitable. Empirical evidences also suggest that the composition of an average Indian’s food basket is gradually shifting towards value added products. It is therefore essential that research priorities in the country should focus on greater value addition for imparting competitive edge to the Indian dairy industry for meeting the emerging challenges of the domestic and global market. A recent survey (February 2006) conducted by the Confederation of Indian Industry also suggests that demand for ready-to-eat foods is growing at the rate of 20% (FICCI, 2006). Value addition per se for the tomorrow’s dairy industry should encompass areas such as new product formulation, shelf life extension using newer preservation technologies, convenience and novel packaging systems. The product portfolio that needs to be addressed to must include particularly the exciting range of traditional dairy desserts with established market. Value addition to this effect will thus not only help in exploiting domestic market-reach of our dairy products but also open new vistas for export to neighbouring countries.

2.0 Technological Gaps

Preservation technologies generally employed for food products are either sterilization or dehydration. Traditional dairy delicacies have unique textural and sensory attributes and require a complex manufacturing protocol to develop such properties. The commonly employed preservation processes do not suit specific needs of most traditional dairy products. It is therefore that the ready-to-reconstitute traditional milk desserts are rarely manufactured at industrial scale and marketed. Furthermore, the severity of heat treatment as employed during sterilization, results in extensive damage to nutritional, rheological and sensory properties. The major challenge exists therefore in combining various unit operations such as tray drying, osmotic dehydration and spray drying into a workable technological process which could deliver a commercially viable technological package for extending shelf life of such traditional dairy products. Modern packaging options also need to be exploited to further enhance the products’ keeping quality as also their acceptability.
3.0 Ready-To-Reconstitute Milk Desserts Developed at NDRI

NDRI has done a commendable work in developing a range of value added traditional dairy desserts, which are ready for transfer to prospective manufactures. Some of these are delineated below.

3.1 Ready-to-Reconstitute Rasmalai Mix

The process comprised of preparation of syrup mix powder and dehydrated patties to be mixed into an instant rasmalai mix (Mishra, et. al., 2004). The syrup mix powder was prepared by dry blending of sweetened milk solids (SMP) powder, whole milk powder (WMP) and sugar powder. To the dry mix, saffron was also added and packed in co-extruded multilayer plastic pouches. The sweetened milk solids powder was prepared from standardized buffalo milk (fat: SNF ratio of 0.35) by heat desiccation. Standardized milk was boiled in a steam-jacketed stainless steel scraped surface heat exchanger to obtain sweetened khoa with a smooth body. The mixture was transferred into a stainless steel tray and allowed to set for 12 h at room temperature. The resulting pat was cut into cubes and dehydrated using a novel technology employed for the first time for manufacturing a dairy product to a moisture content of less than 10 percent (Fig. 1). The dried cubes were ground into a fine powder.

**PREPARATION OF RAS MALAI SYRUP USING OSMOTIC DEHYDRATION METHOD**

\[
\text{Milk-fat/SNF : 0.35} \rightarrow \text{Sweetened Khoa} \text{TS ~78.5} \rightarrow \text{Sugar 5%} \\
\rightarrow \text{Cubes} \\
\rightarrow \text{Ground sugar} \\
\rightarrow \text{Mixing, incubation} \\
\rightarrow \text{Osmotically dehydrated khoa} \\
\rightarrow \text{Grinding}
\]

![Flow-chart for the manufacture of dehydrated Rasmalai syrup phase](image)

Dehydrated patty was prepared with cow milk (standardized to fat: SNF ratio of 0.35) chhana. The chhana balls flattened to patty shape were cooked in the syrup and subsequently partially dehydrated by a standardized dehydration technology till the moisture content was less than 10.0 per cent (Fig. 2). The dehydrated patties were vacuum packed in co-extruded multilayer plastic pouches.

Both syrup mix powder and dehydrated patty were analysed for chemical composition and the results are presented in Table 1.
Table 1: Proximate Composition of Instant Rasmalai Mix

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Dehydrated patty</th>
<th>Syrup mix powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture %, w/w</td>
<td>5.1 - 9.8</td>
<td>4.2 – 5.6</td>
</tr>
<tr>
<td>Fat %, w/w</td>
<td>7.3 - 13.8</td>
<td>17.7 – 18.2</td>
</tr>
<tr>
<td>Protein %, w/w</td>
<td>11.1 – 17.2</td>
<td>12.8 – 19.6</td>
</tr>
<tr>
<td>Lactose %, w/w</td>
<td>1.2 - 1.6</td>
<td>26.1 – 30.3</td>
</tr>
<tr>
<td>Sucrose %, w/w</td>
<td>60.9 - 70.5</td>
<td>27.2– 29.2</td>
</tr>
<tr>
<td>Ash %, w/w</td>
<td>0.7 – 1.2</td>
<td>4.1– 4.5</td>
</tr>
</tbody>
</table>

PREPARATION OF RAS MALAI PATTY USING NOVEL DEHYDRATION METHOD

For rehydration, the syrup mix powder (100g) is poured into a bowl containing 150 ml of water and made into a smooth cream. Measured volume of water (250 ml) is separately taken into a vessel, and brought to boil. The patties are then to be put into boiling water and rehydrated for 2 min. Subsequently, the cream portion is added to the vessel, and boiling continued for further 2 min. The product is then to be brought to room temperature, added with the garnishing and served cool. It was demonstrated through storage study data that the product was acceptable even after 4 months of storage at 30°C.

3.2 Ready-to-Reconstitute Basundi Mix

Ready-to-use Basundi mix was also developed using the concept of osmo-air drying and spray drying (Sharma et. al., 2004). The product mix was formulated by dry blending of ingredients like whole milk powder (WMP), sweetened milk solids (SMS), particulated whey proteins (PWP) and sugar.

The spray dried WMP was prepared from mixed milk standardized to a fat: SNF ratio of 0.27. The sweetened milk solids (SMS) powder was prepared from standardized buffalo milk (fat: SNF ratio of 0.35) by heat desiccation. Particulated whey protein (PWP) was made by coagulating heated whey- and -cow milk mixture with a food grade coagulating agent and
subsequently admixing with partially desiccated sweetened milk solids in predetermined proportion. The entire mixture was transferred to a stainless steel tray and allowed to set for 12 h at room temperature. The resulting pat was shredded and air dried to get desired flakes (Fig. 3). Dried shreds were packaged separately in co-extruded multilayer plastic pouches.

**PREPARATION OF PARTICULATED WHEY PROTEIN USING OSMOTIC DEHYDRATION METHOD**

- **Cow Milk** ➔ **Whey**
- **Heating (90°C)/10m** ➔ **Coagulation/Dewatering** ➔ **Admixing with partially desiccated SMS** ➔ **Shredding/flaking** ➔ **Osmotic dehydration**

**Fig. 3** Flow-chart for the manufacture of dehydrated particulated whey proteins

The optimized mix had the following chemical composition (Table 2).

**Table 2: Proximate Composition of the Optimized Mix**

<table>
<thead>
<tr>
<th>Constituent (%)</th>
<th>Optimized mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>4.15 ± 0.28</td>
</tr>
<tr>
<td>Fat</td>
<td>18.94 ± 0.15</td>
</tr>
<tr>
<td>Protein</td>
<td>21.21 ± 0.17</td>
</tr>
<tr>
<td>Lactose</td>
<td>28.94 ± 0.12</td>
</tr>
<tr>
<td>Sucrose</td>
<td>26.47 ± 0.30</td>
</tr>
<tr>
<td>Ash</td>
<td>4.45 ± 0.05</td>
</tr>
</tbody>
</table>

Data represent mean ± SE of triplicate determination

For rehydration, two hundred milliliters of water was taken into a stainless steel vessel and brought to boil. The entire content of the larger packet containing the dry Basundi mix (powder) was then added with continuous stirring followed by cooking on a low flame for five min. The smaller pack containing flakes was then opened and the content added into the boiling liquid. After about half a minute it was garnished with dry fruits. The product was then cooled and served. Storage study revealed that the product was acceptable after four and half months at 25°C.
3.3 **Khoa Powder**

Ranganadham (1988) developed technologies for small scale and industrial production of khoa powder. The flow diagrams of the methods are depicted in Fig 4. Three different options were tried. In the first option, Khoa, made from standardised buffalo milk by traditional method was grated into flakes and subjected to heat treatment to evaporate moisture before grinding in a small scale laboratory grinder. The ground khoa was uniformly distributed over an aluminium tray and dried in a vacuum and atmospheric hot air oven at 70°C. In the second process, grated khoa was dried in a fluid bed drier with an inlet air temperature of 98°C. It took about 4 hours to dehydrate the product in a hot air oven and 30 min in a fluid bed drier.

The drum drying process was standardized for medium scale operation. Buffalo milk was adjusted to 6 percent fat and 9 percent SNF and heat treated to develop a typical cooked flavour in the final product. The heated and partly concentrated milk was drum dried after adjusting the steam pressure, flow rate of milk and speed of roller drums (Fig 4B). Spray drying technology was considered suitable for large scale production of khoa powder (Fig 4C). Concentrated milk with 30 percent T.S. was prepared from standardized buffalo milk followed by heat treatment to develop cooked flavour. The heated, concentrated milk was instantly dried in an Anhydro spray drier with an inlet temperature of 190°C and outlet temperature of 78°C.

The composition and physico chemical characteristics of khoa powder prepared by the above three methods and that of spray dried whole milk have been shown in Table 3 below:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Tray Dried Khoa (A)</th>
<th>Khoa powder (roller dried) (B)</th>
<th>Khoa powder (spray dried) (C)</th>
<th>Whole milk powder (spray dried)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>3.98</td>
<td>3.75</td>
<td>2.40</td>
<td>2.20</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>31.17</td>
<td>37.07</td>
<td>38.21</td>
<td>27.01</td>
</tr>
<tr>
<td>Proteins (%)</td>
<td>26.73</td>
<td>24.28</td>
<td>23.96</td>
<td>27.08</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>32.98</td>
<td>30.07</td>
<td>30.38</td>
<td>36.85</td>
</tr>
<tr>
<td>Ash(%)</td>
<td>5.14</td>
<td>4.90</td>
<td>5.05</td>
<td>6.15</td>
</tr>
<tr>
<td>Free fat (% on fat basis)</td>
<td>64.73</td>
<td>77.77</td>
<td>63.96</td>
<td>28.17</td>
</tr>
<tr>
<td>P-DMAB (reactivity absorbance at 545 nm)</td>
<td>0.14</td>
<td>0.19</td>
<td>0.31</td>
<td>0.09</td>
</tr>
<tr>
<td>Total HMF values</td>
<td>21.00</td>
<td>25.81</td>
<td>34.06</td>
<td>10.06</td>
</tr>
<tr>
<td>Loose bulk density (gm/cc)</td>
<td>0.45</td>
<td>0.23</td>
<td>0.29</td>
<td>0.37</td>
</tr>
<tr>
<td>Water activity (at 25° C)</td>
<td>0.42</td>
<td>0.38</td>
<td>0.25</td>
<td>0.30</td>
</tr>
</tbody>
</table>
On reconstitution with water, this can be utilized directly for the preparation of burfi, milk-cake, kalakand and gulabjamun. Khoa powder packaged in tin containers under nitrogen gas can be stored for up to 10 months at 30°C.

3.4 Rasogolla Mix Powder

Rasogolla mix powder has been successfully developed employing ultrafiltration at this institute (Pal et al., 1992). Cow skim milk was fist subjected to ultrafiltration to attain 3 fold concentration. The retentate had milk proteins, part of the minerals and lactose as obtained in channa. However excess of the mineral and lactose were removed through diafiltration to make the composition of the retentate identical to chhana. The pasteurized cream was added to diafiltered retentate and subsequently spray dried under standard drying conditions. The dried retentate was blended with selected additives to produce desired flavour and texture.

Both cow and buffalo, standardized milks were used for the manufacture of rasogolla mix powder. The composition is given in Table 4.

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Cow milk rasogolla mix powder (%)</th>
<th>Buffalo milk rasogolla mix powder (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>4.6</td>
<td>4.15</td>
</tr>
<tr>
<td>Fat</td>
<td>31.7</td>
<td>30.9</td>
</tr>
<tr>
<td>Total protein</td>
<td>46.83</td>
<td>43.55</td>
</tr>
<tr>
<td>Ash</td>
<td>4.39</td>
<td>5.49</td>
</tr>
<tr>
<td>Lactose</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Free fat (% of total fat)</td>
<td>66.25</td>
<td>69.33</td>
</tr>
<tr>
<td>Carbohydrates including lactose (by diff.)</td>
<td>12.48</td>
<td>15.91</td>
</tr>
</tbody>
</table>

For manufacture of Rasogolla, an equal quantity of water was mixed to the mix powder and held for about 5 min for rehydration of proteins. The channa dough was shaped into circular balls of about 7 g size in a manner such that no cracks appear on the surface. The balls were first cooked in sugar syrup of 60% concentration for 15 min and later transferred into hot sugar syrup of about 40% concentration.

3.5 Gulabjamun Mix Powder

The GMP, based on roller dried skim milk powder (SMP), consists of the powder, maida, semolina (suji), dalda (vegetable fat), baking powder and cardamom in definite proportions. All the ingredients are dry blended in a power driven mixer such that the ingredients are uniformly mixed. The vegetable fat is added in molten state intermittently to ensure thorough mixing with the dry ingredients. The GMP packaged in laminate pouches and stored in dry place remains acceptable upto 6 months at room temperature. Process has also been standardized for manufacturing Gulabjamun from the GMP. It generally requires preparation of khoa-dough of suitable consistency (50-55 ml water for 100g mix), which
could be made into smooth balls of uniform size and shape and deep fat fried in vegetable oil (Dalda) at about 125°C for 15-20 min. The properly fried balls acquire brown colour which are subsequently transferred into hot sugar syrup of known brix. Even when SMP and vegetable fat were completely replaced with whole milk powder in the GMP formulation, product characteristics remained largely unchanged. Use of spray dried SMP in place of roller dried SMP was not found acceptable as it led to case hardening of balls during deep fat frying and prevented the sugar syrup penetration thereby resulting in unacceptable product. However certain alterations in the ingredients viz., use of high heat SMP, increase in fat content from 15% in roller SMP based formulation to about 18% in spray based SMP, use of additives such as CMC and sodium citrate and/or addition of dried whey protein concentrates (1-2% of SMP) to the mix, helped in improving the textural properties of the product and resulted in highly acceptable product. However GMP based on spray dried SMP requires certain modifications in manufacturing procedure such as increase in the holding time of dough and frying at slightly lower temperature. The shelf life of spray dried SMP based formulation was comparable to GMP based on roller dried SMP (Rajorhia and Dharam Pal, 1989).

3.6 Instant Kheer mix

Instant Kheer mix (Jha, 2000) manufacture involves spray drying of admixture of milk concentrate and rice flour (preheated to partially pre-gelatinize the rice starch) along with sugar followed by fluidized bed drying to make the powder which has excellent reconstitution properties. Rice grains which could be readily rehydrated were obtained by a technology which involved partial cooking of rice, it’s conversion into a paste, subsequent extrusion and dehydration in air dryer. This form of instant rice was rehydrated in about 5 min. Alternatively, quick cooking rice was obtained by drying of partially cooked rice in a fluidized bed dryer. The rice thus obtained could be cooked in hot water in about 10 min.

Spray dried Kheer powder mixed with instant rice was packed in metallized polyester laminates and could be stored at room temperature without any loss of quality for a period of 6 months.

3.7 Instant Kulfi mix

Manufacture of Kulfi mix powder (Ghosh, 1991) involves preparation of a mix from milk fat (11%), MSNF (16%), sucrose (15%) and isabgol husk (0.2%). The total solids concentration of the mix is adjusted and only 25% of the total sugar required in the final mix is added before drying. The mix is homogenized at 6.83/3.43 MPa, heated at 100°C for 10 min in a tubular heat exchanger followed by cooling to 4°C. The mix is spray dried. The remaining sugar in ground form is dry blended with the powder and packaged in tin cans. The proximate chemical composition of kulfi mix powder is fat 25.41% MSNF 36.98%, Isabgol 0.46%, Sugar 34.65% and moisture 2.52%. The product has a shelf-life of 7 months at 30°C in tin cans. The shelf-life can be extended up to 10 months with the addition of butylated hydroxy anisole (BHA) and nitrogen gas flushing. Kulfi mix powder can be instantly reconstituted and frozen to get kulfi of consistently good quality all the year round at an affordable price. It ensures the production of pathogens-free frozen product.
4.0 Conclusions

A wide variety of traditional dairy delicacies, drawn from different regions of the country, are produced in India using processes such as heat and/or acid coagulation, desiccation and fermentation. Traditional milk sweets and dairy desserts form the large bulk of such products. However, tremendous economic potential of this sector has remained untapped because of the fact that the manufacture of traditional dairy products has remained confined to small level operations, which is manual and energy intensive. Therefore what is needed is adoption of existing unit operations and machines to upgrade and mechanize manufacturing processes of traditional dairy products. The products developed at NDRI, are an attempt in this direction. It is expected that such ready mixes would add convenience to the existing array of customary dishes. Value addition to this effect will not only help in exploiting domestic market-reach of our dairy products but also open new vistas for export to neighbouring countries.

5.0 Suggested Readings


CEREAL-BASED CONVENIENCE FORMULATIONS FOR TRADITIONAL DAIRY PRODUCTS

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1.0 Introduction

Consumer convenience along with safety is the key to value addition in dairy and food processing industries. In this context, technology development for process upgradation of certain traditional dairy products is obviously the topical area of research geared to cater to the need of the industry for avenues to diversify its activity with local and export markets in view. In this context, kheer and dalia are two important cereal-based food products, which are popular throughout the country but have no organized manufacturing and marketing system (Aneja, 1997).

Kheer is popular in the northwest, central and eastern parts of the country, and is popular as Payasam in the southern states. It has been the premier milk delicacy associated with festivities and celebration from time immemorial. Hindu mythology refers to it as the celestial nectar, 'Amrit' or elixir and gives it a place of prominence among foods as the secret of immortality- the life giving food. The two great epics of the Hindu mythology provide evidence of its popularity. Since those times of kings and nobles, kheer has maintained its place of prominence in the Indian diet. No fiesta is considered complete without kheer as dessert. Similarly, dalia as a milk-wheat porridge is quite common in many parts of the country both as a breakfast food as well as health food.

Many traditional foods have remained unchanged with regard to processing or packaging for centuries, due to the fact that they developed in a particular location and are deep rooted in the natural, cultural, religious and socio-economic environment. Some have disappeared without a trace as a result of modern influences, while some have expanded on a global scale, becoming household products. Kheer and dalia, cereal-based particulate dairy desserts are unique products representing dairy and food processing going hand in hand. Unfortunately, as is the case with other traditional dairy products, kheer and dalia making have also remained confined to domestic level only. Their poor shelf life coupled with lack of technology for organized large-scale manufacture have been major deterrents in exploitation of its commercial advantage, both in domestic and international markets. Concerted attempts were made at National Dairy Research Institute, Karnal to develop commercial processes for organized manufacture of kheer in the form of a dry mix and also as ready-to-serve product in retort pouches and dalia in the form of ready-to-serve product in retortable cans.
2.0 Instant Kheer Mix – Product Diversification for Dairy Industry

Though popular throughout India, its limited shelf life even under refrigeration imposes severe restrictions on its organized manufacture and marketing. It was envisaged that if a process were developed for kheer in a shelf-stable form, it would offer significant value addition and product diversification for Indian Dairy Industry. In the past two decades, several attempts have been made including the use of preservatives to extend the shelf life of kheer, but these have met with a limited success. Production of kheer in a dry form suitable for ready reconstitution could be conceived to help overcome the problem of shelf life of this popular traditional product.

A process has been developed at NDRI, Karnal to manufacture an instant rice-based kheer mix. It consists of separate drying-cum-instantization of the milk and rice phases of the product. The powdered portion obtained by two-stage spray-bed process, and containing 1.9% moisture, 18.2% fat, 15.3% protein, 2.5% total ash and 62.1% total carbohydrates, is somewhat similar to the sugar-containing partially skimmed milk powder, or the presently marketed dairy whiteners. The rice grains which have been so processed as to make them quick-cooking are carried in a small pouch placed in the metallized polyester/LDPE bag used for packaging of the kheer mix powder. The mix has a shelf life of at least 6 months at 37°C. Reconstitution of kheer mix involves rehydration of instant quick-cooking rice in boiling water for 10 min followed by dispersal of the powdered component into the rice-water mixture. The reconstituted product could be suitably flavoured and enriched with dry fruits etc. This product has been found to have a high acceptance rating in a consumer study (Jha, 2000). Such a dry mix has a great potential to be commercially viable commodity in the Indian dairy products market.

2.1 Functional Properties of Instant Kheer Mix Powder

The physical nature of spray dried powders are vastly different from those obtained by other drying methods such as drum drying, freeze drying etc. In order to fully characterize the new product, systematic studies were conducted to analyze its functional properties (Jha et al., 2002). Some of the important functional properties are presented in Table 1. The powdered milk fraction has a better flowability and higher bulk density as compared to whole milk powder or skim milk powder.

2.2 Advantages of Instant Kheer Mix over Conventional Kheer

Product development work on kheer mix assumes greater significance in the context of numerous advantages, which it offers over the conventional product. Some of the important advantages of instant kheer mix powder are enumerated below:
- Process upgradation for the manufacture of traditional dairy products
- Shelf life of kheer enhanced to 6 months as compared to 2-3 days for conventional product.
- Considerable convenience to consumers - no sourcing of raw materials
- Kheer making time reduced to about 10 min as compared to nearly 1 hour in conventional process
- Savings in terms of fuel during kheer making
- Safe and hygienic product in attractive packaging
- Value addition to farmer’s milk
- Opportunity for dairy industry for product diversification
- More avenues for tapping export market using indigenous dairy products
- Offers nutritional advantages of rice and milk in packaged form
- Nutritious and delicious food for our Armed Forces, which can be easily transported to difficult areas without any refrigeration
- Easy to be manufactured even by small scale industries and existing dairy plants having spare spray drying facility
- Low cost of manufacture as compared to similar dairy desserts in the market
- Removal of drudgery for housewives and working women during conventional kheer making.

Table 1: Functional Properties of Instant Kheer Mix Powder

<table>
<thead>
<tr>
<th>Property</th>
<th>Mean (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowability (angle of repose, degrees)</td>
<td>40.09 (38.30-42.64)</td>
</tr>
<tr>
<td>Wettability (min)</td>
<td>2.00 (2.00-2.00)</td>
</tr>
<tr>
<td>Dispersibility (%)</td>
<td>75.38 (69.73-86.51)</td>
</tr>
<tr>
<td>Insolubility index (ml)</td>
<td>4.00 (3.00-5.00)</td>
</tr>
<tr>
<td>Loose bulk density (g/cc)</td>
<td>0.69 (0.67-0.73)</td>
</tr>
<tr>
<td>Packed bulk density (g/cc)</td>
<td>0.81 (0.80-0.83)</td>
</tr>
<tr>
<td>Particle density (g/cc)</td>
<td>1.25 (1.25-1.25)</td>
</tr>
<tr>
<td>Occluded air content (cc/100 g)</td>
<td>6.63 (5.90-7.00)</td>
</tr>
<tr>
<td>Interstitial air content (cc/100 g)</td>
<td>45.00 (45.00-45.00)</td>
</tr>
<tr>
<td>Porosity (%)</td>
<td>44.80 (41.60-46.40)</td>
</tr>
</tbody>
</table>

3.0 Developments in Instant Vermicelli Kheer Mix

In some of the studies conducted at DFRL, Mysore, a kheer mix has been developed based on reconditioned vermicelli, milk powder, sugar and flavourants. It is a nutritious, low fat and energy rich food which provides 386 Kcal/100g. The product has been found to have the required chemical and microbiological stability for 6 months at 37°C (Jayathilakan et al., 2000). The product is highly suitable for all ages, particularly for hospital patients, school children and also useful for disaster relief operations.

4.0 Developments in Instant Dalia Mix

*Dalía*, a milk and wheat-based, particulate containing dairy dessert is popularly consumed as a breakfast food and is also considered as a health food in India. However, its limited keeping quality even under refrigeration and lack of an industrial process for its large-scale manufacture, has not allowed it to come out of the confines of the domestic kitchen. It is regarded more as a house-hold product cooked for immediate consumption rather than as a value added food product, which could also find a place in consumer market.
In order to promote *dalia* dessert as a marketable product, a process has been developed for manufacture of instant *dalia* mix, as a dry product with long shelf-life, which can be attractively packaged and easily reconstituted for consumption, any time, any where. The product development consist of powdered liquid phase and particulate phase. Later, the milk concentrate along with added wheat flour and sugar is dried in two-stage spray drier with integrated fluidized bed drier for agglomeration of the product (powdered liquid phase). The particulate part consist of instantized *dalia* made by precooking whole wheat grains for pre-gelatinization and drying the cooked grains in Fluidized Bed Drier and cracking them into *dalia*. The product so developed was packed in PE-Paper board cartons.

Instant *dalia* mix (complete with *dalia* grains, which is cracked wheat) contains 3.33% moisture and 12.70% fat, 13.11% protein, 2.58% ash, 8.41% free fat and 6.54% amylose. The freshly prepared powder has a good flowability (angle of repose, 53.31°) and fairly high loose and packed bulk densities (0.58 g/cc and 0.81 g/cc, respectively) corresponding to a particle density of 1.38 g/cc, occluded air content of 1.30 cc/100g, interstitial air content of 51.25 cc/100g and porosity of 38.56 %. It shows an insolubility index of 2.5 ml, wettability of 35.66 seconds, and dispersibility of 78.84 %. Reconstitution in boiling water yields a product, which is highly acceptable.

### 5.0 Long-Life Rice Based Kheer

A process has been recently developed for in-package cooking and sterilization of kheer in retort pouches with the objective to enhance its shelf-life at ambient temperature. Sterilization was done in steam-air environment, using a Rotary Pilot Scale Retorting System employing a constant rotation of 2 rpm. Retort temperature and pressure were set at 121.1°C and 15 psi respectively. An overpressure of 30 psi was maintained to prevent bursting of pouches. Concentrated milk, raw rice (washed and soaked at 30°C/30 min.) and sugar were filled in retort pouches (size 200 mm x 170 mm) having a configuration of 12 polyester, 12 al-foil and 350 gauge cast polypropylene. Retort pouches used in the study had a bursting strength of 40 psig for 30 seconds and heat seal strength of 84 N/25 mm width in cross direction and 98 N/25 mm width in machine direction. Retort pouches were fitted with a temperature-measuring probe consisting of a Cu/Cu Ni thermocouple, a packing gland made of polyoxymethylene and two rubber O-rings. Time-temperature data were recorded during heat processing using an Ellab data recorder-cum- $F_o$ & cook value integrator. Heat penetration indices were determined by constructing a graph on an inverted semi-log paper (Temperature deficit in 0°C versus time in min.). A typical process studied had $J = 0.514$, $f_h = 6.30$, $U = 15.10$ min., $f_h/U = 0.417$, $B = 19.65$ min., Total process time = 24.29 min and $F_o$ value of 14.76. *Kheer* obtained by this process with a composition of fat 6.21 %, protein 10.75 %, total solids 28.67 %, ash 0.74 % and carbohydrates 53.63 % and the product had a shelf-life of more than 4 months at 37°C. This approach to enhance the shelf life of one of the important traditional dairy desserts could also be applied to other dairy/food products.

### 6.0 Long-Life Dalia Dessert

The advent of retort processing technology has made the availability of shelf stable Ready-to-Eat (RTE) foods a reality in the Indian market. A variety of lip-smacking Indian dishes such as Dal Makhani, Aluchhole, Chana Masala, Navrattan Korma, Palak Paneer,
Sambar Rice etc. are now readily available off the shelf (Rangarao, 2002). With food processors like Tasty Bite Eatables, MTR Foods, ITC Foods, Satnam overseas, ADF Foods and many others dishing out newer and newer products to meet the demands of the Indian palate, the RTE foods business is reported to have reached a turnover of Rs. 60–80 crore during the current year (Menon, 2003; Bhushan, 2003). In line with the current scenario of ready-to-eat products picking up great markets, a commercial process for manufacturing dalia dessert has also been developed. Various wheat varieties (both durum and aestivum) were screened for their physico-chemical properties before converting them into dalia grains. The fully developed product contained 29.60% total solids, 3.56% protein, 0.84% ash and 21.54% carbohydrates including 2.88% amylase. Product in tin-free steel cans had a shelf-life of 72 days at 37°C ($F_0 = 4.15$ and nisin 376 IU/g). Technology can be easily adapted by the user industry more diversified production operations in the increasingly competitive market.

7.0 Commercial Milk-Cereal Formulations

In India, Farex has introduced a wheat apple milk-cereal based weaning food. It has a balanced mix of essential nutrients which contain protein, carbohydrates, vitamins, minerals and iron. It is easy to digest and does not contain any artificial preservatives, colours or flavours. Weaning formulations have also been developed based on sorghum, groundnuts, sesame seeds, chickpeas and skim milk powder and processed by a twin-roller drum dryer. These formulations were found to have compositions and properties comparable to those of cerelac, which is a more popular weaning food (Mahgoub, 1999).

8.0 Challenges Ahead

Cereal-based milk products in various forms are very popular in all the regions of the country. Technology of making these appetizing delicacies remain confined to domestic level in the absence of any viable alternative for their commercial manufacture. Growth in this area has also been hindered because of the inadequate shelf life of these desserts for commercial marketing. To exploit the full potential of these products in terms of their nutritional qualities and foreign exchange earnings, strong support is needed to develop the processes for improving the shelf life as well as uniformity of product quality and hygiene. Valuations of several traditional dairy products such as ghee, khoa and chhana in terms of their annual output and their monetary contributions to the output of Indian dairy industry have been worked out. However, no such attempt has been made for kheer and dalia. One reason for lack of information is the absence of organized manufacturing and marketing of this product. However, if we take into account the popularity of these products, their importance in value output can be easily recognized. In our country, large-scale marketing of several brands of ready-to-reconstitute kheer/payasam mixes on regional basis has been started especially in states like Karnataka, Kerala and Tamil Nadu. Most of these products are reconstitutable in milk and are basically a blend of processed rice or semolina, ground sugar, and dryfruits. Of late, such mixes have become very popular as they offer considerable convenience to consumers. Development of suitable processes for commercial manufacture of cereal-milk based convenience foods will hopefully provide a necessary fillip to the contribution of traditional dairy products in National dairy economy.
9.0 Suggested Readings
1.0 Introduction

The unique feature of traditional milk products is that they are obtained by a wide variety of methods involving a range of unit operations such as atmospheric evaporation (concentration), acid coagulation, fermentation, processing of coagulum, frying, cooking and so on. In many cases, the finished product is obtained by processing or co-processing of primary or intermediate products such as khoa and chhana in conjunction with various dairy or non-dairy ingredients using different treatments. Obviously, this leads to a great range of product structures and textures, each of the recognized products and their innumerable variants having specific characteristics which appeal to the consumer. The texture may vary from a simple liquid consistency through semi-solid plastic consistency to solid spongy balls also and even very hard solids (e.g. Churpi, a coagulated and dried product of the North-East).

As regards the traditional pattern of production, the major problem in respect of quality is general and texture in particular, is the lack of consistency and uniformity. Further, the growing demand for traditional milk products point to the need of their manufacture in modern dairy plants, improved packaging, shelf-life and safety, all without any compromise on the eating quality of the product. The product’s texture needs particular attention in this context. Retaining the product’s complex texture while following modified or new processes is a real challenge to the manufacturer. If a high-moisture product is to be transformed to a dry one, preserving the product’s textural uniqueness would call for great ingenuity and considerable research and development efforts. Packaging would have to be so designed that the product does not lose its textural identity during the course of transportation and handling. Gulabjamun and Rasogolla are examples of such products. When addressing to the challenges posed by traditional dairy products in relation to their texture, one crucial need is to identify the product’s textural characteristics the consumer looks for, and then to work out suitable methods for their measurement. Therefore, an attempt is made here to discuss, in brief, the approaches in qualitative and quantitative evaluation of texture of foods in general and traditional dairy products in particular.

2.0 Texture vs. Rheology

The chemical constituents giving rise to the physical structure determine a product’s texture. ‘Food texture’ is thus defined as the way in which various constituents and structural elements are arranged and combined into a microstructure leading to a macrostructure, and
the external manifestation of flow and deformation as perceived by the human sensory apparatus (organs). The physical entity or ‘body’ of a food arising from its macrostructure studied in terms of deformation and flow using appropriate mechanical means is called ‘rheology’. While the rheological behaviour of a product could be taken to relate to its sensory texture, rheology may also have other implications such as that in process equipment design and process control. Rheology, i.e. the way food will behave when a force is brought to act upon it, as seen through the resulting force-deformation or force-flow relationship has been important to the food processor from the point of view of both the production and handling of a product in the plant and the texture of the finished product as it matters to the consumers.

As texture is perceived by the unique and complex human senses, the stimulus giving rise to the perception (response) is predominantly mechanical in nature. Thus, instrumental measurement of texture generally involves mechanical methods although recently acoustic methods of texture assessment of certain crunchy foods have also been developed. While instrumental measurements are valued for their objectivity in results, even sensory measurements, when carried out on scientific principles, can give highly reliable and reproducible results.

3.0 Sensory Texture Profile Analysis

Characterization of a product’s texture is valuable in process development studies as also in monitoring of textural quality in routine production. A quantitative and reasonably reproducible approach is developing a texture profile by using a trained sensory panel. Texture Profile Analysis (TPA) refers to identification and quantification of various constituent perceptions of texture which give the overall texture impression, i.e. the individual texture attributes such as hardness, gumminess, chewiness, etc. are identified in a product sample primarily by finger-feel and mastication, and a numerical value (intensity rating) assigned to each attribute. The quantitation is critical to TPA and requires adequate training of the panelists in conjunction with the use of suitable ‘standards’ or ‘references’ to go by.

Sensory TPA has been worked out for indigenous milk products viz. khoa, chhana, paneer, kalakand, milk-cake, peda, gulabjamun, rasogolla, sandesh, chhana-murki, kheer, etc. at this institute. Sensory TPA data could usefully be related to instrumented measurements on product texture. However, for these data to be meaningful, the references (or standards) should be carefully selected. In the studies conducted at this institute, various milk products generally served as standards as, for example, green Cheddar cheese as “definitely hard” and butter at 25°C as “soft”, and the panelists used a 100-point (10-cm) linear intensity-rating scale (0 – extremely soft, 100 – extremely hard).

Attempts have been made to profile and relate the sensory TPA data to chemical composition. Such relationships are feasible in certain products but not in others. Further, not all texture attributes may show meaningful relationships with compositional characteristics. Depending on the product structure, certain chemical parameters may show significant bearing on selected texture attributes. Moisture content of a product by far is the most
important variable for most products in this regard, although fat and protein contents could play a significant role too.

4.0 Instrumental Methods

It has been pointed out that while texture refers to sensory perception of the force-deformation relationship in a product, rheology gives an instrumental measurement of the latter. Thus, instrumental data can be related to sensory data with a view to making instrumental assessment of the sensory texture of a product. It follows from this that instrumental measurements may be intended to evaluate the sensory texture of a product. However, instrumental data may be used, depending upon the method of measurement, also for other purposes such as in designing of equipment for food processing and packaging, and predicting the physical behaviour of the product during processing or post-production handling.

4.1 Classification of Instrumental Methods

Depending upon the test conditions with regard to the applied force and the resulting deformation (or flow) in conjugation with sample geometry, instrumental methods can be termed as (i) empirical (or, imitative), or (ii) fundamental (or, engineering) methods. The fundamental methods, generally relying on small deformations (non-destructive tests), are so conducted as to yield data in well defined (physical or engineering) units of mechanical properties such as viscosity for fluid materials and various modulii for solid materials. The results are independent of the test conditions and are applicable to engineering design considerations. Such tests are, however, more relevant to pure engineering materials rather than complex materials such as foods. Nevertheless, considerable information has been generated on the rheological (or, engineering) properties of various foods.

The data from empirical methods, on the other hand, are highly dependent on the test conditions and methods are usually product-specific. Data generated by these generally large-deformation methods (destructive tests) are useful in comparing different products under identical test conditions and the magnitude of the values are meaningless without being qualified by the test conditions. Empirical data are not amenable to engineering treatment and interpretation. However, empirical methods have been very useful in practice for determining the effects of process variables and storage conditions on texture of a range of food products. Also, they employ relatively simple and cost-effective instruments which do not require highly skilled operators to use, and routine measurements for quality assurance can be made in most practical situations. While fundamental rheological measurements are made in a compression, tension, torsion or shear mode, empirical approaches also include penetration, extrusion, cutting, pressing, etc.

4.2 Viscometric Measurements

Viscosity measurements are most common to fluid products. Liquid foods may be of Newtonian or non-Newtonian nature. Newtonian fluids exhibit a viscosity (resistance to flow, measured as the ratio of shear stress to shear rate) which does not vary with the shear
The viscosity of non-Newtonian foods is, however, shear-dependent. Accordingly, such foods are classified as either shear-thinning type (characterized by a decreasing viscosity with increasing shear rate) or shear-thickening (dilatant) type (wherein the viscosity increases with increasing shear rate), the former being most common to fluid foods. For example, milk with 30% or more total solids is shear-thinning. The ‘apparent viscosity’ of products such as Basundi should, therefore, be qualified by the shear rate used. Alternately, a series of measurements may be made on a non-Newtonian product using a range of shear rates and the stress-shear rate relationship from the set of data generated expressed in terms of parameters of an appropriate mathematical expression, such as ‘consistency coefficient’ and ‘flow behaviour index’ in the most frequently used ‘power law’ model.

An important rheological feature of many viscous foods is ‘thixotropy’. Upon shearing of thixotropic sample at a constant (shear) rate, its viscosity falls due to structural breakdown until eventually it reaches a constant value. Upon undisturbed storage of the product, the structure tends rebuild although the recovery may not necessarily be complete, with the result that the ‘initial’ viscosity of the product after agitation and storage may be lower than the original initial viscosity. Products such as Rabri and stirred Dahi are examples of thixotropic products. Although the initial viscosity is an important measure of a product’s consistency to the consumer, comparison of different samples in terms of initial viscosity often become difficult because of the difficulty in preserving the product structure before making the measurement. While the ‘final’ or equilibrium viscosity may enable desired comparisons, it may not always be relevant to the product’s texture (consistency) when it is consumed.

Difficulties in textural or rheological measurements on flowable foods also arise when they contain solid particles which tend to settle or segregate. Rice-kheer or Dalia desserts are the products in point. To overcome such problems, special viscometer geometries may be used such as a rotor with ridges (in case of coaxial cylinders viscometers) or an impeller or T-spindle as the rotor (in a spindle viscometer). Though useful in getting viscometric results, such devices often give empirical results.

4.3 Viscoelastic Measurements

The thixotropic character of certain liquid foods discussed above relate to the so-called ‘time effect’ in rheological measurements. Most solid and semi-solid foods exhibit the time effect in relation to their force-deformation characteristics. In other words, such foods are ‘viscoelastic’, i.e. their reaction to a stress comprises partly ‘viscous’ (Newtonian) flow and partly ‘elastic’ deformation, the latter referring to a recoverable change in their dimensions. The combined liquid-like and solid-like behaviour is measured as a time-dependent stress-strain (force-deformation) relationship, usually in small deformation modes (or, non-destructive tests). Viscoelastic measurements are generally carried out either through ‘transients’ tests or ‘dynamic’ tests. The results obtained from such measurements are in terms of parameters of well established rheological models describing the force-deformation phenomenon in the product. Such mechanical models include Maxwell model, Kelvin model, Burgers model and a few others. One of the important parameters is ‘relaxation time’ enshrined in each of these models. The methods for viscoelastic measurements on foods are
relatively involved and necessitate use of sophisticated equipment. These are, therefore, not suitable for routine analysis.

Characterization of traditional milk products such as paneer has been attempted by employing ‘stress relaxation’ experiments, and the data have been fitted to mechanical models such the ‘generalized Maxwell model’. ‘Stress relaxation’ experiments pertain to measurement of the stress (resulting upon a definite deformation or strain) as a function of time while the strain remains unchanged. Another type of transient experiments is ‘creep’ wherein the change in strain under constant stress is monitored as a function of time and thereby ‘retardation’ or ‘creep compliance’ data generated. Although viscoelastic measurements give results of ‘fundamental’ nature, useful in relating to the product’s texture as well as in applications to equipment design, not much has been done in this area of research. Considerable scope exists for employing the viscoelastic concepts in texture evaluation of traditional dairy products most of which are viscoelastic rather than purely elastic or purely viscous.

4.4 Instrumental Texture Profile Analysis

In recent times, most instrumental measurements on traditional milk products have been made using the Texture Profile Analysis (TPA) approach. In TPA, the sample is usually subjected to large deformation (in the destructive range) primarily to simulate the chewing action and results are obtained in terms of parameters such as hardness, cohesiveness, gumminess, chewiness and springiness. However, these results are highly dependent on the test conditions and, therefore, empirical in nature. Several attempts have been made to relate the individual TPA parameters to the corresponding sensory attributes but with varying success. While TPA hardness has been a very useful parameter and to some extent, TPA springiness has also been found meaningfully related to sensory springiness (or elasticity), the other parameters have been of little significance in most products. Yet TPA has been a valuable tool in product or process development studies as also in product characterization. The TPA has become particularly common in recent times owing to the availability advanced instrument facilities such as Instron Universal Testing Machine and several texture analysers devoted to food products analysis, e.g. SMS Texture Analyser and a number of other machines equipped with very versatile softwares. Texture characterization of khoa and khoa-based sweets, chhana, rasogolla, paneer, etc. has been carried out during the past two decades at this institute.

5.0 Conclusion

During the past 20 years, attention has been focused on the texture of traditional milk products. Products such as khoa and khoa-based sweets, chhana and its sweets, paneer, rabri, etc. have been characterized by instrumental texture profile analysis (TPA). TPA has also been used for quantifying the effects of process variables and storage conditions on the texture of several indigenous milk products. However, very limited attempts have been made towards more objective type rheological measurements on these products. While the empirical approaches such as TPA, facilitated by modern software-assisted texture analysers, are valuable in product development and process modification, it would be worthwhile to
generate fundamental rheological data for more meaningful product characterization which would help in process-equipment design.

6.0 Suggested Readings


1.0 Introduction

Food is an integral part of Indian culture and it is rooted in the concept of good life and good cheer. This holistic approach is reflected in the numerous varieties of delicacies that judiciously combine delectable flavour with assured nutrition for body and mind. The variation in delicacies may be attributed to community, region and state. Each religion, region and ethnic groups has left its own influence on Indian food. Since time immemorial milk is converted into wide array of milk products and at present approximately 50% of the milk produced in India is utilized for the manufacture of traditional dairy products including sweets, coagulated products, frozen products, fat rich products. Many of these products are no more confined to only specific part of the country but are produced at commercial level and marketed both in domestic and exotic markets. However, still a large number of products are prepared at home or cottage level, consumed only in certain section of the society and many of such products are becoming extinct from the map of Indian cuisines. In recent years with the re-emergence of organized dairy industry and disappearance of cultural barriers, certain products have been characterized and attempts have been made to develop technological package for commercialization.

2.0 Region Specific Traditional Milk Products

Raw milk is converted into a number of products utilizing the process of desiccation, acid-heat coagulation, fermentation and sometime designed with other non-dairy ingredients to satisfy the palate of consumers. Variety exists mainly due to difference in type and composition of milk, manufacturing method, ingredients utilized and also preferences of end users. Some of the regional dairy products are presented in Table 1.

3.0 Chhana Podo

_Chhana Podo_ perhaps the only dairy product that is prepared by baking the dough of chhana, Sugar, wheat flour or semolina. The product is very popular in Cuttack district of Orissa. The product is believed to be originated in Puri and has been served to Lord Jagannath as prasad for hundreds of years.

“Podo” means “burning” in Oriya language and most probably it relates for baking of Chhana over slow fire in traditional method of manufacture. _Chhana Podo_ because of characteristic flavour, appearance and texture is quite popular throughout Orissa and NDDB,
Anand after realizing its popularity has developed the technology and equipments for large-scale production of *Chhana Podo*.

**Table 1: Regional Dairy Products of India and Indian Sub-continent**

<table>
<thead>
<tr>
<th>Product</th>
<th>Region</th>
<th>Description of the Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kachhagolla</td>
<td>Bengal Bangladesh (Natore District)</td>
<td>Kachhagolla is high moisture sandesh; characterized by granular texture, sweet and delicate flavour.</td>
</tr>
<tr>
<td>Chomchom</td>
<td>Bengal Bangladesh (Tangil District)</td>
<td>Oval shaped chhana based sweet radish brown in colour, denser texture than rashogolla and impregnated with crystal sugar.</td>
</tr>
<tr>
<td>Gasa-Gase Paysam</td>
<td>Karnataka</td>
<td>Poppy seed, coconut powder, sugar milk based <em>paysam</em> having light cream colour, pleasant poppy flavour and rich mouthfeel.</td>
</tr>
<tr>
<td>Sekram</td>
<td>Sikkim, Arunachal Pradesh, Nepal, Tibbet.</td>
<td>Prepared by boiling and draining liquid portion of buttermilk. Solid is called <em>Sekram</em>, which is consumed as fresh or kept for months for natural fermentation.</td>
</tr>
<tr>
<td>Satori</td>
<td>Maharashtra Marathwada Region</td>
<td>Deep fat fried product containing mixture of khoa, sugar and semolina as stuffing material inside a dough ball. Reddish brown colour.</td>
</tr>
<tr>
<td>Mahi / Mohi</td>
<td>Sikkim, Daryiling Hills</td>
<td>Similar to buttermilk’ rich in fat and made from whole or skimmed milk curd fermented by natural souring involving Lactic Acid Bacteria (LAB)</td>
</tr>
<tr>
<td>Kalan</td>
<td>Kerala</td>
<td>Butter milk, raw banana, coconut and elephant yam based culinary preparation served during auspicious occasions. Thick in consistency and light yellow in colour and highly acidic. Fairly stable at room temperature.</td>
</tr>
<tr>
<td>Surati Paneer</td>
<td>Surat District of Gujarat</td>
<td>Soft Cheese made from Buffalo milk with crude rennet, salted and kept in acid whey for 2-3 days. Fairly firm body &amp; texture with no internal cracks. Slightly salted, mild acid-curd flavour.</td>
</tr>
<tr>
<td>Bandel Cheese</td>
<td>Bandel, a Portuguese colony in eastern India.</td>
<td>Indigenous unripened, salted soft variety of Cheese made in perforated pots made from cow’s milk. The Cheese is formed into a flattered circular shape.</td>
</tr>
<tr>
<td>Dacca</td>
<td>Eastern Region of India</td>
<td>Similar to Bandel but finished flat round cheeses are smoked in a fire.</td>
</tr>
<tr>
<td>Karad Kheer</td>
<td>Maharashtra</td>
<td>Kheer based on roasted safflower extract and milk along with rice.</td>
</tr>
<tr>
<td>Sitabhog</td>
<td>Burdwan District</td>
<td>Made by mixing Chhana and refined wheat flour into dough, extruding in the form of thread, deep frying in refined oil / ghee and dipping in sugar syrup.</td>
</tr>
</tbody>
</table>
3.1 Product Characteristics and Composition

Wide variations exist in the product quality sold in traditional market of Orissa. The colour of the product ranges from creamy white to light brown depending on the baking from top/bottom/both surface. The body of the product may be characterized as loose, compact, pasty, firm, spongy and particulate type. Normally cardamom and clove are used as flavouring agent. In certain products excess syrup oozes out. The height of cake also varied considerably (Ghosh et al., 2002). The variation in the product characteristics may be attributed to level of raw material and method of baking Ghosh et al. (2002) on the basis of their survey of Chhana Podo in Orissa from 16 production centre, classified it into as Dry and Wet type. They also reported chemical composition of Chhana Podo and found that sugar and fat, are the major constituent followed by protein, starch and ash. Khamrui et al. (2003) investigated the influence of levels of ingredients on Textural Profile Analysis (TPA) of Chhana Podo and observed significant interrelationship among textural parameters particularly hardness with fracturability, adhesiveness, springiness, cohesiveness, and gumminess; springiness and cohesiveness with gumminess, chewiness and resilience. They concluded that one or two most important parameters could probably served as an index of the textural quality of the product to serve as regular quality assurance purposes.

3.2 Ingredients and Manufacturing Procedure

Chhana, Semolina and sugar are the most commonly used raw material. However, in some places refined wheat flour (maida) is used in place of semolina and resultant product is smooth textured. Nuts, raisins, cardamom and cloves are used as minor ingredient to improve the acceptability of the product.

In the traditional method of manufacture, Chhana is mixed with about half of sugar and semolina (5%), made into smooth dough by kneading, transferred in aluminum vessels and baked over red hot burning wood. During baking some burning charcoal pieces are kept on the top as well as bottom for 2-4 hours. In rural areas the dough is cooked after wrapping in Sal (Shorea robusta) leaves.

Another method of manufacture involves baking of dough on flat bottom cast iron plate. The specially designed plates have about 2” projections at the edges and generally round in shape. During heating the container is heated slowly from the bottom and top is covered with sal leaves, where small quantity of burning charcoal is kept. The product made by this method is wet type, high in moisture with delicate flavour and chewy texture. Ghosh et al. (1998) standardized the manufacturing procedure that can be adopted at commercial level and it involved mixing of chhana (from 3.5-4.0% fat), sugar, maida and suji, kneading the mix to completely dissolve sugar, transferring the dough into presmeared pan to a thickness of 2 cm and baking at 200°c for 65 min. The product contained moisture (30-33%), fat (21-23%), protein (15-17%), sugar (18-21%), ash (0.1-0.3%) and starch (6-8%).

4.0 Churpi

Dhudh churpi or chhurpi, a traditional fermented milk product of north-eastern part of the Indian subcontinent is quite popular. Churpi is made from cow or yak or dzno milk...
and depending upon the moisture content may be classified as soft and hard churpi. It is a rich source of milk protein, energy and minerals. The product possesses characteristics flavour and pronounced chewiness that help in maintaining salivation during traveling in hilly terrain. Beside all these it is one of the effective way of value-addition of surplus milk and preservation of milk nutrients in remote areas.

4.1 Product Description and Manufacturing Procedure

Churpi is essentially a milk protein concentrated with low moisture content. Traditionally it is prepared by acid heat coagulation of partially defatted milk. The coagulated mass is cooked and then pressed heavily overnight. The pieces of coagulum are partially dried over the warmth of a wood fired oven for 25 –30 days (Pal et al., 1993). Thapa (2000) described the traditional method of churpi preparation from yak milk. Yak milk is first converted into fermented milk and then churned out to separate buttermilk and butter. Buttermilk is further processed into sher; a cottage cheese type product by heating, coagulating and light pressing. If it is fermented then resulting product is called sewsew and alternatively heavy pressing and drying produce churpi.

Pal, et al. (1996) optimized the processing parameters for the manufacture of churpi by standardizing the milk to 1.0% fat, 8.7% SNF, heating to 70°C and coagulating the milk within 60 sec using hot (70°C) 2% citric acid solution. Resulting whey was removed by filtering through muslin cloth and the coagulated mass thus obtained was cooked in a stainless steel container over hot water bath followed by pressing at 9Kg/cm² pressure for 12 hours. The pressed coagulum was cut into pieces of equal sizes (4 cm x 2 cm x 2 cm), smoked for 30 min with wood charcoal and dried in hot air oven at 30°C to a moisture level of 30% (w/w). Product is called as pre-churpi and in order to improve its palatability pre-churpi may be cooked in concentrated milk (2.5% fat, 21.75% SNF, 5.0% sucrose and 29.25% total solids) as described by Hossain et al. (1999) for 15 min. Hossain et al. (1999) further investigated the effect of fat level in cooking milk and cooking tine on quality characteristics of dudh churpi and found that concentrated milk from 1.0% fat level and cooking period of 15 min produced the most acceptable product in terms of chemical composition and organoleptic quality. Tamang et al. (2000) isolated the predominant Lactic Acid Bacteria from soft variety churpi and identified Lactobacillus casei subspp. casei, Lactobacillus plantarum, Enterococcus faecium as a major microbial species.

5.0 Rabadi

Rabadi is an indigenous natural lactic acid fermented beverage, popular in north-western semi-arid regions of India. At homes, rabadi is prepared by mixing and fermenting the flour of wheat, barley, pearl millet, sorghum or maize with home made butter milk in earthen or metallic vessel during hot summer days in open sun or at room temperature (35-40°C), kept for 4-6 hr, followed by boiling, salting to taste, cooling and consuming (Dhankher, 1985). The product is creamy-white, slightly viscous, acidic and possess pleasant flavour. Rabadi is nutritionally superior, natural, microbiologically safe and organoleptically acceptable product (Gupta et al, 1992). Fermentation of the buttermilk-cereal flour mix improves the nutritional profile of the resulting product as natural microflora degrade or inactivate inherently present anti-nutritional constituents of cereal flours. Khetarpaul and
Chauhan (1992) studied, fermentation of raw as well as autoclaved wheat flour with buttermilk at 30, 35 and 40°C for 6, 12, 18, 24 and 48 h, and found that the level of phytic acid was significantly decreased. Maximum reduction in phytic acid content was observed at 40°C for 48 h. Starch as well as protein digestibility (In vitro) improved with an increase in the temperature and period of fermentation.

An acceptable rabadi-like fermented beverage can be manufactured by mixing 2 to 3 percent 24h germinated wheat flour with skim milk followed by gelatinization at 90°C for 15 min, cooling to 37°C, inoculating with NCDC-263 at 2 percent and incubating at 37°C till the acidity reached 1 % LA. The curd obtained was mixed with water in the ratio of 2.5: 1. CMC (0.15%), pectin (0.6%), salt (0.7%) and spice mix (0.2), were blended with the mix and the beverage was thermally processed at 80°C for 15 sec, bottled and cooled immediately. The optimized product contained 9.8 percent total solid, 2.54 percent protein, 0.28 percent fat, 1.36 percent ash and acidity of 0.76 percent as lactic acid. The product was acceptable up to 6 days under refrigeration conditions (Girish, 2006). The technology developed can be adopted at commercial level for the manufacture of rabadi with wheat flour and skim milk. Processing parameters have been optimized for the production of rabadi from pearl millet and sorghum.

### 6.0 Doda Burfi

Another product that has been described as softer fudge like variation-resembling burfi called ‘Doda’ is quite popular in northern state specially Punjab and Haryana. No standard recipe or manufacturing detail has been available about this product. In traditional method, product is usually made from raw buffalo milk that is inoculated with curd culture and left for 2-3 hour after milking to develop acidity. Then admixture of normal wheat flour and germinated wheat flour (angoori atta) is added into milk (flour to milk ratio 1:10) and left undisturbed at room temperature for 1 hour, the mixture is cooked in a shallow pan over a slow flame and when milk starts coagulating, the temperature is raised. The sugar is added when almost 3/4th moisture had been evaporated and cooked quickly. The product is cooled, garnished with dry fruits and cardamon and cut into rectangular shaped pieces.

Jha (2003) has developed a method to manufacture Doda burfi at laboratory level. Standardized buffalo milk (SNF 12 per cent) is acidified using 50 per cent citric acid and allowed to rest for 15 min. Desired proportions of wheat flour and malted wheat flour is blended and passed through a sieve 2-3 times to mix them properly. The blended four mix is added in standardized milk maintaining the flour to milk ratio as 1:8 and left for 25 min in order to moisten the flour components. Slurry is poured into the thick walled shallow aluminum pan and it is heated around 60°C. Slurry is stirred continuously with circular motion using laden in order to avoid sticking of flour at the bottom of utensil and also to produce curd particles of small and uniform size. Heating is continued with co-current stirring and scraping with the help of a scraper to avoid the burning till pasty consistency is obtained. At this stage, sugar is added and temperature of the product is quickly raised to 80°C to dissolve sugar with continuous heating. The product became thick in consistency and turned brown in colour. The process is terminated when free fat started oozing out. The whole mass is poured in stainless steel moulds, allowed to cool and pieces of uniform sizes are cut.
Further investigation revealed that burfi made with lower level of milk fat had gritty texture and bitter flavour. It was light brown in colour and dull in appearance. However, the products that were prepared from 4.5% and 6.0% fat containing milk, possessed large sized granules and had desired degree of cohesiveness, characteristic caramelized flavour and brown in colour. Sugar level of 16.5 per cent was acceptable and addition of sugar towards the end point of burfi manufacture was preferred. Gajbhiye et al (2005) standardized the process of manufacturing Doda burfi and found 7% dry sprouted wheat grain, 7% sugar and 2% wheat flour on milk weight basis were most acceptable combination.

7.0 Kunda

Kunda and Dudhpak are similar milk based delicacies popular in northern Karnataka specially the Belgaum District and adjoining areas of Maharashtra. These semi solid delicacies are prepared by the concentration of milk and subsequent desiccation with the addition of sugar. The desiccation with incorporated sugar gives a characteristic brown colour to kunda. Kunda/Dudhpak can be defined as a desiccated light brown to dark brown product, prepared by the continuous heating of milk or high moisture khoa mixed with calculated amount of sugar. The product has rich characteristic milk fat taste with a nutty and caramelized cooked flavour (Kulkani et al, 2001). The addition of sugar (about 30%) and low moisture content (about 25%) contribute for the relatively long shelf-life of the product which enables its wider marketing.

7.1 Product Characteristics and Composition

Scientists at Southern Regional Station of NDRI, Banglore conducted a market survey of Kunda samples to characterize the product and anlayse samples for chemical constituents. The samples were evaluated for four important organoleptic attributes and the information collected is summarized hereunder.

Colour and Appearance: The colour of the product varied from light brown to brown colour. In certain cases fat bloom i.e solidified milk fat was observed all over the surface of the product. The darker products were observed to keep for longer time as compared to the lighter product.

Body and Texture: Kunda has a soft body and grainy textural characteristics. When the product was pressed with fingers, fat was observed to stick to the fingers.

Mouthfeel: The mouthfeel characteristics indicated a smooth body, granular texture and a characteristic after-taste in the mouth. Flakes of fat obtained on the tongue also gave richness to the product.

Flavour: The flavour of kunda was observed to be sweet, nutty and pleasant. The fat flavour was observed to be predominant in the product. Certain amount of cooked flavour was noticed in the product. This flavour was also observed to contribute positively to the characteristic flavour of kunda.

Chemical composition of the product indicated wide variations in the sample collected from three major production areas. Sucrose was the major constituent followed by fat, lactose and protein.
7.2 Manufacturing Technology and Process Innovation

Traditionally, buffalo milk is used for the manufacture of kunda and for commercial production high moisture khoa is used as starting material. The khoa is mixed with crystalline sugar (20-25% w/w) and cooked over low flame in shallow vessel till free fat starts oozing out. At this stage product attained pleasant caramel flavour and form a cohesive lumpy mass, which do not stick to the bottom or sides of the vessel. The product is spread in thin layer over a tray and allowed to cool.

In order to reduce the cooking time and save energy process innovation was attempted by replacing a part of crystal sugar by caramelized sugar and addition of 40% caramelized sugar of the total sugar produced most acceptable kunda that was quite similar to marketed ones. It also reduced the manufacturing time to as low as 30 min resulting in about 45% reduction in processing time and about 35% effective saving in steam/heat energy consumption.

The shelf-life studies on commercial samples indicated that light brown kunda kept well for about 4 days at ambient temperature (29°C) compared to about 12 days in case of dark brown kunda. The spoilage was observed to begin with the visible growth of yeasts and molds. Vacuum packaging of kunda using 65-micron film of LDPE was observed to increase the shelf-life to about 12 days for light brown product and to about 20 days for the dark brown product. At refrigerated temperature (5 - 8°C), vacuum packaged light brown product kept nearly for 2 months while the vacuum packaged dark brown product was observed to keep beyond 3 months.

8.0 Kradi

Kradi is coagulated partially fermented milk product and it is manufactured primarily by the nomadic tribes of Kashmir mainly Gujars & Bakkerwals living in the hills of Shopian, Kupwara, Pahalgam, Poonch, and Rajouri areas. The Gujar and Bakerwals are poor and backward sections of society whose main source of income are milk & milk products from the livestock. Kradi making is an art handed down from generation to generation of these tribes. Kradi is well relished by all the sections of people, particularly by the affluent class of society. It is either eaten raw or used in preparation of Kashmiri dishes. No documented literature is available on Kradi and it has been mentioned by Lawrence an englishman more than a century ago in Gazettes as famous traditional milk product of Jammu and Kashmir and referred as “milk bread”.

8.1 Product Characteristics and Processing Techniques

Kradi is a type of fresh un-ripened cheese made by heat coagulation of buffalo milk and lassi i.e. butter milk, a by-product of homemade butter. It resembles Mozzarella cheese and somewhat similar to Ricotta cheese. It is cylindrical or oval in shape very similar to chapatti with white to creamish yellow surface. The product has smoky, slightly acidic, fermented flavour and characterized by chewy, fibrous and elastic body. In traditional method of manufacture whole buffalo milk and buffalo milk lassi i.e. cultured buttermilk are mixed in certain proportions and heated to coagulate the mix. The whey is separated and coagulated mass floats on the surface. The curd is recovered, strained and spread hot on
smooth surface to form into *Kradi* by rolling in circular motion. It is either consumed as such or dried.

Traditionally *Kradi* is preserved by sun drying. It is a rich source of milk proteins, milk fat, fat-soluble vitamins and minerals. It is thus a highly nutritious dairy product, providing many dietary nutrients that are essential for human system. It is easy to cook compared to other varieties of cheese. Since it is stretched hot this destroys all lactic micro flora and inactivates enzymes. Despite its immense popularity no attempt has been done to characterize and standardize the processing parameters for acceptable quality of product.

9.0 Other Regional Traditional Dairy Products

9.1 Phirni

A delicious variant of kheer, called *phirni* is prepared by cooking milk with rice paste and sugar (Aneja *et al*., 2002). It is believed to be introduced by Mughals and one of the essential food items at religious and auspicious occasions. The product is quite popular in Kashmir valley. To prepare *Phirni*, milk and rice paste were mixed in the ratio of 1:10 along with 15 per cent sugar (w/w) and cooked with continuous stirring until the milk started to thicken. The cooking continued till a desired consistency was achieved and product is cooled to room temperature, dispensed into individual serving containers and further cooled to 4°C under refrigeration (Mathur *et al*., 1985). Saffron and cardomon are added to impart light yellow colour and delicious flavour in the product.

9.2 Ghewar

A milk sweet preparation with admixture of wheat flour called *ghewar* is rare delicacy of northern India. *Ghevar* is a favourite festive disc shaped sweet having cream yellow to orange brown shades of colour (attributable to the surface colour of caramelized sugar). For manufacturing *ghevar*, a thin slurry of refined wheat flour (*maida*) in emulsified fat, is deep fat fried into a doughnut shaped honey comb structure and sweetened with sugar syrup (Aneja *et al*., 2002). Dressing the product with dried fruits, nuts or a thin layer of rabri is optional. Saxena *et al*. (1996) have investigated the preparation, packaging and storage requirement of *ghevar*. The manufacturing procedure consisting of preparation of oil in water emulsion by step-wise blending of iced milk in melted fat in a blender followed by a smooth dough formation by folding *maida* into emulsion. Water is added in this dough to form thin emulsion/slurry and the resulting slurry is added (drop by drop) directly into pre-heated (165°C) frying medium in a specially designed circular flat iron sauce pan till a large doughnut shaped structure as honey comb of golden colour is formed. The doughnut is placed to remove excess fat and sugar syrup is slowly poured over the *ghevar*, cooled and packed. There was significant difference between the LDPE packed and open tray stored samples and remained acceptable for 60 days.

9.3 Bal Mithai

*Bal mithai* is a sweetmeat and immensely popular in Kumaon hills of Uttaranchal. The Bal mithai of Almora is relished and quite famous. The product is dark brown, chewy,
sticky, granular and have pleasant caramelized flavour. Traditionally, Bal mithai is offered to hill god.

The product is made from cow or buffalo milk by heat desiccation on slow wooden fire till it turns deep brown in colour. The product is rich source of energy, quality protein, minerals and other growth promoting constituents. Due to its low moisture and high sugar content Balmethai has a sufficiently longer shelf-life (Jha and Kumbhar, 2003). The solid obtained is called as “Chocolate” which is cooled to set and cut into pieces. If the “Chocolate” is studded with white small marble like sugar ball then it is termed as Bal mithai. In another method khoa is cooked in heavy-bottom shallow pan on slow fire with intermittent stirring till the colour turns brown. Sugar is then added and the mix is heated continuously till a thick consistency is attained. Finally, the product is poured into greased trays and allowed to cool. The product is finally rolled over small sugar ball that give it marble like appearance.

10.0 Conclusions

Milk based indigenous sweets and other products have an established market not only in country but also in other countries where Indian ethnic population is at large. Therefore, these products have a great potential of becoming an important item of export. The manufacture of these products remains localized in specific areas of the country. There are wide variations in the process of manufacturing being used that influence their quality, shelf-life and acceptance by consumers. Moreover, most of the traditional methods are not suitable for large-scale production. Attempts have been made of technological or scientific significance in certain regional traditional milk products to provide products of uniform quality. It is envisaged that development of suitable technological package right from the procurement of raw material up to distribution to consumer in highly uniform, safe and organoleptically acceptable form with good storage stability would offer significant value addition and product diversification for Indian Dairy Industry.

11.0 Suggested Readings


1.0  Introduction

Cultured dairy products constitute a vital component of the human diet in India as in many other regions of the world. Dahi, mishti dahi and shrikhand figure prominently in people’s diet in different parts of India. Besides imparting nutrition and novelty, these products help preserve the precious nutrients in fluid milk which is prone to quick deterioration. There are numerous references to dahi in the ancient Vedas. Milk was fermented with green leaves, palasha bark and putica creeper. Dahi (dadi) was eaten with barley or rice. Churning of dahi to make butter at home and utilize the refreshing buttermilk with leftover grains of butter in it, as a refreshing drink, has been practiced for several centuries. Lord Krishna as a child was fond of dahi and makhan (indigenous cultured white butter). As a playful child, he also teased the curd and butter selling maids by targeting their earthen pots of dahi & butter with small pellets. In other words cultured dairy products find a very prominent position in the Indian culture, food habit and religious ethos.

These products were traditionally prepared at small scale in each household, now the industrial production of some of these products has become a big commercial activity industry (Fig.1). Around 9% of the total milk produced in India is converted into fermented milk products and this sector is showing an annual growth rate of more than 20% per annum (Fig. 2).

2.0  Dahi

2.1  Characteristics

Dahi is one of the most popular milk product used in India from time immemorial. It is obtained by lactic fermentation of cow or buffalo milk.

Traditionally, the ‘back-slopping’ (use of a portion of previous day’s dahi as a starter) is practiced in domestic conditions to prepare dahi in India. A good quality dahi is of firm and uniform consistency with a sweet aroma and clean acid taste. The surface is smooth and glossy and cut surface is firm and free from cracks and gas bubbles.

Dahi is the mother of all fermented milk products as it is the base material for lassi and shrikhand also used as an intermediary in the manufacture of desi butter and ghee. The consumption of dahi is governed by a number of factors, such as food habits, availability,
purchasing power and region of the country. Dahi is used for culinary purpose like making kadhi, Rajasthani rabadi, sweetened shake with different flavors & sugar—lassi, dahi bahlla etc. The average composition of dahi is given in Table 1.

According to PFA (1954), dahi or curd is the product obtained from pasteurized or boiled milk by souring, natural or otherwise, by a harmless lactic acid or other bacterial culture. Dahi may contain additional cane sugar. It could have the same percentage of fat and solids-not-fat as the milk from which it is prepared.

The Bureau of Indian Standards (BIS, 1980a) describes dahi as a product obtained by lactic fermentation through the action of single or mixed strains of lactic acid bacteria or by lactic fermentation. Dahi shall be of the following types: a) Plain, and b) Flavored. The following cultures shall be used in preparing dahi.

a) *S. lactis, S. diacetylactis, S. cremoris*: Single in combination with or without *Leuconostoc* species, and

b) Also as above along with species of *Lactobacillus* such as *L. bulgaricus* and *L. acidophilus*, and *L. casei* and *S. thermophilus*.

The composition of dahi shall be according to the type of milk used and given on the label. Fermented milk shall be prepared from any class of milk (buffalo, cow, goat or sheep, standardized, recombined, toned, double toned and skimmed), pasteurized or boiled (BIS, 1980a). Standards for different classes of milk shall be according to the PFA Rules, 1955 (Masud, et. al, 1991). The following may be added to dahi provided addition does not exceed 25 per cent by mass of the final product.

- Sugar may be added according to the requirements of the consumer.
- Flavoring essences shall be selected from those permitted under the PFA Rules, 1955.
- Flavored extracts and various artificial flavors shall be pasteurized at 63 °C/ 30 min before use.
- Stabilizer permitted under the PFA Rules, 1955 when used, shall not exceed 0.2 per cent by mass of the product.
- The addition of sugar and stabilizers may be done prior to treatment but stabilizers may be added even after partial fermentation of the milk.

According to Indian Standards dahi should have titratable acidity (as lactic acid) of, 0.6 – 0.8%; yeast and mold count not more than 100/g; coliform count below 10/g; and phosphate negative.

Shrikhand is a traditional fermented and sweetened milk product of Indian origin and popular in Gujarat, Maharashtra and certain parts of Karnataka, Madhya Pradesh and Rajasthan. In addition to these traditional places, it is becoming popular in other parts of the country. It has also great export potential.
Shrikhand has a typical semi solid consistency showing a characteristics firmness and pliability contributing to its suitability for consumption with 'Puree' or 'bread'. The consistency is influenced to great extent by the moisture, fat and sugar levels in shrikhand. Shrikhand is still largely produced on small scale adopting age old traditional methods. Now, it is also commercially manufactured in organized dairy sector. Because of the change in the economic status and food habit of consumers, the other varieties of shrikhand, such as fruit shrikhand, are also in great demand.

According to PFA (1954) rules shrikhand shall contain not less than 8.5 per cent milk fat (on dry basis), not less than 9.0 per cent protein (on dry basis), and should not contain more than 72.5 per cent sugar (on dry basis). Same PFA standards implies to fruit shrikhand as for plain shrikhand except that the fat content in it shall not be less than 7.0%. The detailed PFA standards for chakka and shrikhand are given in Table 2. Shrikhand is prepared by blending chakka with sugar, cream and other ingredient like fruit pulp, nut, flavor, spices colour etc. to achieve the finished product of desired composition, consistency and sensory attributes.

Dahi, being a traditional dairy product, is produced in every household using cow, buffalo or mixed milk. In the household, milk is boiled, cooled to room temperature, inoculated with 0.5 to 1 per cent starter (previous day’s dahi or buttermilk) and then allowed to set undisturbed overnight. During winter season, dahi setting vessel is usually wrapped up with woolen cloth to maintain warmth.

Restaurants and sweetmeat shops are practicing a short set method (curd within 4 to 6 hr) for production of dahi. They also use a portion of the previous lot as inoculum (thermophilic starters) followed by incubation at 42 to 45°C till setting of the curd. The milk is concentrated by boiling for a few minutes. This increases the total solids. Dahi is usually set in a circular earthen-ware mould (De, 1980). This type of dahi is meant for counter sale or served in the restaurant to customers.

Now dahi is prepared at industrial scale in organized dairy sector. Fresh, sweet, good quality milk (cow buffalo or mixed) is received. It is then standardized to have 4 – 5 percent fat and 10 to 12 per cent solids-not-fat (in order to improve the body), pre-heated to 60°C and homogenized at a pressure of around 176 kg/ sq. cm. The milk is pre-treated at 80°C to 90°C for 15 to 30 min, cooled to 40 – 45°C and inoculated with 1 to 2 per cent of specific starter culture. It is then filled in suitable containers (glass bottles/ plastic cups etc.) of required capacity using automatic filling and sealing machines. The cups are kept in stackable trays and incubated at 40 – 42°C till curdling (3 – 4 hr). When a firm curd is formed, dahi cups are stored in a cold room (4°C).

The starter cultures for dahi have originated through natural souring of milk and the composition varies depending upon the procedure of making dahi and maintaining the culture. Two factors have played important role in the development of the typical microflora, low pH has selected mainly the acid producing and acid tolerant lactic acid bacteria, and temperature of incubation. However, the mixed microflora contains several types of organisms. Lactic microflora of dahi has been studied by many workers. Different reports
S. lactis, S. cremoris, L. acidophilus and S. elipsoides were isolated from dahi samples (Madhok, 1942). In another study streptococci were found to be predominant in samples of dahi in Northern parts of India as compared to predominance of lactobacilli in the South. Laxminarayana, et. al. (1952) isolated 290 strains of streptococci and 430 strains of lactobacilli from dahi. S. faecalis dominated the streptococcal isolates, followed by S. lactis and S. thermophilus. Majority of the lactobacilli (310 out of 430 isolates) were identified as Lb. bulgaricus, followed by L. casei and L. brevis (Laxminarayan, et. al, 1952). Studies from Dacca (Bangladesh) showed 78.9% Streptococcus spp., 17.5% Lactobacillus spp. and the rest as micrococci, yeasts and aerobic sporeformers (Aneja, et. al, 2002). Predominance of S. thermophilus has been reported from Pakistan and North India (Sheikh, et. al, 1970; Masud, et. al, 1991). Apparently the microflora depends on the incubation temperature and time of incubation and storage. These undefined starter cultures have their own advantages as follows: The cultures do not require specific temperature and perform over a range of temperature.

1. They show comparatively better performance in milk containing low levels of inhibitory residues.
2. These cultures are phage resistant as the sensitive strains are automatically removed through natural infections and the resistant get selected.

On the other hand there are many disadvantages of these cultures as listed below:

1. The cultures do not give a consistent product as the composition of the strains varies affecting acidity and flavor production.
2. The make time varies from batch to batch as acid production depends upon the dominance of strains.
3. The product is likely to develop certain defects like continued acid production during storage, gas production by leuconostocs etc.

Modern industry has switched over to the use of defined strain starters. The starter contain the selected strains which are fully characterized for their taxonomic and technological characteristics. The cultures are tested for:

1. Rate of acid production at different temperatures
2. Citrate utilization and diacetyl production
3. Proteolytic activity
4. Intracellular polysaccharide production
5. Slime production or ropiness
6. Production of off-flavor, if any
7. Antagonistic behaviour in co-culture – bacteriocin production
8. Sensitivity to bacteriophages
9. Antibiotic resistance profile

The cultures strains are short listed and used for making blends of starters or used as single strain cultures. Acid producers like Lactococcus lacis spp. cremoris (LC) may be
paired with diacetyl producing lactococci (LD) or leuconostocs. Triplet or multiple strain formulations are used quite frequently to include EPS producing strains as in case of stirred yoghurt. The defined strain starters offer following advantages:

1. Their behaviour is well established and performance can be predicted and monitored easily.
2. There is little variation in make times and production schedules can be maintained as planned.
3. The quality of the product is consistent as there is not strain imbalancing or dominance.
4. The quality of the product is consistent and there is little variation from batch to batch.
5. Mostly available from commercial culture companies as direct bulk or direct vat preparations (freeze-dried or frozen) and convenient to use.

We have studied various formulations of cultures at NDRI for making Dahi and combination permutations have been used to select the culture strains and prepare paired, triplet or multiple starters. The cultures were screened for acid production, proteolytic activity and diacetyl production (data not given). The different combinations of starters were short listed after conducting the trials and finally sensory evaluation was done. Most strains could coagulate the milk in 6 – 7 hours at 37 °C, whereas proteolytic activity showed wide variation. The cultures strains used in the study are listed in Table 3. A total of 21 combinations of paired starters were evaluated, out of which 57.1% exhibited loose body and texture, 28.5% exhibited semi firm and only 14.2% exhibited firm body and texture. Pair Number 9 (61 + 74) took shortest time of 6 hrs for dahi setting as the make time ranged between 6 – 10 hours for different pairs (Table 4). A total of 30 cultures were formulated as triplets and the make time was again 6 hours or more, however, the flavor and other attributes showed better results as compared to paired starters. Out of 30 combinations tested, four combinations No. 5, 16, 20 and 21 recorded average titratable acidities between 0.78% to 1.23% with average setting time of around 6 h. Three of the combinations showed moderate flavor production and firm body, creamy texture, glossy appearance and absence of wheying-off (Table 5.)

Fourteen different combinations, each comprising of one flavor producer and three acid producers were used for multiple strain formulations for dahi making. The results are presented in Table 6. Dahi made from all the combinations recorded acidities ranging from 0.81% - 1.57% with average flavor production and moderate to excessive wheying-off. The setting time was between 5-6 hrs for all combinations except combination 1. Two culture formulations i.e., 60 + 92 + 86 + 74 (Sl.No.4) and 60 + 91 + 86 + 292 (Sl.No.13) also produced moderate flavor.

The selected cultures from the above three types of formulations were taken up for post acidification studies. These comprised of two paired, four triplets and two multiple strain combinations. Dahi was prepared using these combinations and stored at 5 – 7 °C. Titratable acidity was recorded at 24 h intervals for 10 consecutive days. Two triplet
combinations i.e. No. 5 (60, 91, 74) and No.16 (61, 9, 74) produced lowest post acidification reaching to a final acidity of 1.25% and 1.30% after 10 days of storage.

The above selected formulations were used for making frozen DVS cultures which showed good characteristics and stability upto 3 months of storage. The cultures were grown in whey based media, harvested by centrifugation and resuspended in skim milk with glycerol for deep freezing at -70 °C. The products from two DVS formulations were further evaluated for different parameters. The studies showed encouraging results and it is recommended that more emphasis should be given to evaluate more strains and conduct studies on freeze-dried DVS preparations or direct bulk set cultures to help the dairy industry in producing good quality fermented milks in India.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Cow milk</th>
<th>Buffalo milk</th>
<th>Skim Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>85-88</td>
<td>82-85</td>
<td>89-92</td>
</tr>
<tr>
<td>Fat</td>
<td>3.5-4.5</td>
<td>6.0-8.0</td>
<td>0.05-0.1</td>
</tr>
<tr>
<td>Protein</td>
<td>3.0-3.5</td>
<td>3.5-4.0</td>
<td>3.3-3.5</td>
</tr>
<tr>
<td>Lactose</td>
<td>3.8-4.5</td>
<td>4.6-5.2</td>
<td>4.7-5.3</td>
</tr>
<tr>
<td>Ash</td>
<td>0.64-0.66</td>
<td>0.7-0.72</td>
<td>--</td>
</tr>
<tr>
<td>Lactic Acid</td>
<td>0.5-1.0</td>
<td>0.5-1.1</td>
<td>0.5-1.1</td>
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<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total solids</th>
<th>Milk Fat</th>
<th>Milk Protein</th>
<th>Titratable acidity</th>
<th>Total Ash</th>
<th>Sugar</th>
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<tr>
<td>Chakka</td>
<td>30 min</td>
<td>33 min</td>
<td>30 min</td>
<td>2.5</td>
<td>3.5</td>
<td>-</td>
</tr>
<tr>
<td>Skimmed Milk chakka</td>
<td>20 min</td>
<td>5.0 max</td>
<td>60 min</td>
<td>2.5</td>
<td>5.0</td>
<td>-</td>
</tr>
<tr>
<td>Shrikhand</td>
<td>58 min</td>
<td>8.5 min</td>
<td>9.0 min</td>
<td>1.4 max</td>
<td>0.9 max</td>
<td>72.5 max</td>
</tr>
<tr>
<td>Fruit Shrikhand</td>
<td>58 min</td>
<td>7.0 min</td>
<td>9.0 min</td>
<td>1.4 max</td>
<td>0.9 max</td>
<td>72.5 max</td>
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</table>

<table>
<thead>
<tr>
<th>Bacterial species</th>
<th>NCDC Strain Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>L. lactis</em> ssp. <em>lactis</em></td>
<td>91</td>
</tr>
<tr>
<td><em>L. lactis</em> ssp. <em>lactis</em></td>
<td>92</td>
</tr>
<tr>
<td><em>L. lactis</em> ssp. <em>cremoris</em></td>
<td>86</td>
</tr>
<tr>
<td><em>L. lactis</em> ssp. <em>cremoris</em></td>
<td>83</td>
</tr>
<tr>
<td><em>L. lactis</em> ssp. <em>lactis</em> biovar diacetylactis</td>
<td>60</td>
</tr>
<tr>
<td><em>L. lactis</em> ssp. <em>lactis</em> biovar diacetylactis</td>
<td>61</td>
</tr>
<tr>
<td><em>L. lactis</em> ssp. <em>lactis</em> biovar diacetylactis</td>
<td>65</td>
</tr>
<tr>
<td><em>S. thermophilus</em></td>
<td>74</td>
</tr>
<tr>
<td><em>S. thermophilus</em></td>
<td>80</td>
</tr>
<tr>
<td><em>Lb. delbrueckii</em> ssp. <em>Bulgarcus</em></td>
<td>09</td>
</tr>
<tr>
<td><em>Lb. helveticus</em></td>
<td>292</td>
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</table>
Table 4: Screening of paired starters* for dahi making

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Combination</th>
<th>Average Setting time (h)</th>
<th>Titratable acidity (%)</th>
<th>Flavor (Creatine test)</th>
<th>Wheying-off (ml)</th>
<th>Body &amp; Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60, 91</td>
<td>8.50</td>
<td>0.74</td>
<td>+++</td>
<td>12.5</td>
<td>Loose</td>
</tr>
<tr>
<td>2</td>
<td>60, 86</td>
<td>8.50</td>
<td>0.76</td>
<td>++</td>
<td>15.0</td>
<td>Loose</td>
</tr>
<tr>
<td>3</td>
<td>60, 74</td>
<td>8.30</td>
<td>0.75</td>
<td>-</td>
<td>11.0</td>
<td>Semi-firm</td>
</tr>
<tr>
<td>4</td>
<td>60, 9</td>
<td>8.30</td>
<td>0.76</td>
<td>+</td>
<td>16.0</td>
<td>Semi-firm</td>
</tr>
<tr>
<td>5</td>
<td>60, 92</td>
<td>6.40</td>
<td>0.74</td>
<td>++</td>
<td>5.0</td>
<td>Loose</td>
</tr>
<tr>
<td>6</td>
<td>60, 83</td>
<td>6.10</td>
<td>0.72</td>
<td>+</td>
<td>8.0</td>
<td>Loose</td>
</tr>
<tr>
<td>7</td>
<td>61, 91</td>
<td>10.00</td>
<td>1.27</td>
<td>+++</td>
<td>12.0</td>
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<tr>
<td>8</td>
<td>61, 86</td>
<td>10.00</td>
<td>1.13</td>
<td>+++</td>
<td>14.0</td>
<td>Semi-firm</td>
</tr>
<tr>
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<td>61, 74</td>
<td>6.00</td>
<td>0.87</td>
<td>++</td>
<td>10.0</td>
<td>Firm</td>
</tr>
<tr>
<td>10</td>
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<td>6.42</td>
<td>0.97</td>
<td>++</td>
<td>13.0</td>
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</tr>
<tr>
<td>11</td>
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<td>1.33</td>
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</tr>
<tr>
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</tr>
<tr>
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<td>0.99</td>
<td>++</td>
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</tr>
<tr>
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<td>0.92</td>
<td>++</td>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>18</td>
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<td>1.03</td>
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<td>10.0</td>
<td>Loose</td>
</tr>
<tr>
<td>19</td>
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<td>0.97</td>
<td>-</td>
<td>4.0</td>
<td>Semi-firm</td>
</tr>
<tr>
<td>20</td>
<td>65, 292</td>
<td>7.50</td>
<td>1.00</td>
<td>-</td>
<td>12.0</td>
<td>Firm</td>
</tr>
<tr>
<td>21</td>
<td>65, 80</td>
<td>7.50</td>
<td>0.78</td>
<td>-</td>
<td>7.0</td>
<td>Semi-firm</td>
</tr>
</tbody>
</table>

* Each pair comprises of one acid producing strain and one cit+ aroma producing strain

Figure 1. Growth of fermented milk products in India
Table 5: Screening of triplet starters* for dahi making

<table>
<thead>
<tr>
<th>Sl. NO.</th>
<th>Combinations</th>
<th>Average setting time (h)</th>
<th>Titratable acidity (%)</th>
<th>Flavor (Creatine test)</th>
<th>Wheying-off (ml)</th>
<th>Body and Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>60,91,86</td>
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<td>0.99</td>
<td>+++</td>
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</tr>
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</tr>
<tr>
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</tr>
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</tr>
<tr>
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<td>0.92</td>
<td>±</td>
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<td>Semifirm</td>
</tr>
<tr>
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<td>60,92,292</td>
<td>6.30</td>
<td>0.97</td>
<td>+</td>
<td>3.0</td>
<td>Semifirm</td>
</tr>
<tr>
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</tr>
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<td>0.96</td>
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<td>Semifirm</td>
</tr>
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<td>Semifirm</td>
</tr>
<tr>
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</tr>
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<td>Firm</td>
</tr>
<tr>
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<td>7.5</td>
<td>Firm</td>
</tr>
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<td>-</td>
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<td>-</td>
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<td>Semifirm</td>
</tr>
<tr>
<td>21.</td>
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<td>++</td>
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<tr>
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<td>0.91</td>
<td>-</td>
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</tr>
<tr>
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<td>±</td>
<td>9.3</td>
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</tr>
<tr>
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<td>65,91,9</td>
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<td>1.00</td>
<td>-</td>
<td>13.5</td>
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</tr>
<tr>
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<td>65,91,292</td>
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<td>1.22</td>
<td>-</td>
<td>10.6</td>
<td>Firm</td>
</tr>
<tr>
<td>26.</td>
<td>65,91,83</td>
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<td>0.73</td>
<td>±</td>
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<td>Loose</td>
</tr>
<tr>
<td>27.</td>
<td>65,86,74</td>
<td>9.00</td>
<td>0.76</td>
<td>±</td>
<td>15.2</td>
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<tr>
<td>28.</td>
<td>65,86,9</td>
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<td>1.06</td>
<td>-</td>
<td>10.0</td>
<td>Semifirm</td>
</tr>
<tr>
<td>29.</td>
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<td>1.19</td>
<td>++</td>
<td>9.5</td>
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</tr>
<tr>
<td>30.</td>
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<td>7.30</td>
<td>0.91</td>
<td>-</td>
<td>8.5</td>
<td>Loose</td>
</tr>
</tbody>
</table>

*Each combination comprised of two acid producers and one citaroma producing strain
Table 6: Screening of multiple strain starters* for dahi making

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Combination</th>
<th>Average setting time (h)</th>
<th>Titratable acidity (%)</th>
<th>Flavor (Creatine test)</th>
<th>Wheying off (ml)</th>
<th>Body &amp; Texture</th>
</tr>
</thead>
<tbody>
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<td>0.81</td>
<td>++</td>
<td>8.0</td>
<td>Loose</td>
</tr>
<tr>
<td>2</td>
<td>60,92,83,74</td>
<td>6.00</td>
<td>1.15</td>
<td>-</td>
<td>6.5</td>
<td>Loose</td>
</tr>
<tr>
<td>3</td>
<td>60,92,292,74</td>
<td>5.00</td>
<td>1.12</td>
<td>±</td>
<td>8.5</td>
<td>Semi firm</td>
</tr>
<tr>
<td>4</td>
<td>60,92,86,74</td>
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<td>-</td>
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<td>Semi firm</td>
</tr>
<tr>
<td>7</td>
<td>60,83,9,74</td>
<td>5.00</td>
<td>1.22</td>
<td>±</td>
<td>6.2</td>
<td>Firm</td>
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<td>1.18</td>
<td>-</td>
<td>12.5</td>
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<tr>
<td>9</td>
<td>60,83,91,74</td>
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<td>±</td>
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<td>Loose</td>
</tr>
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<td>1.34</td>
<td>-</td>
<td>7.4</td>
<td>Loose</td>
</tr>
<tr>
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<td>60,83,91,292</td>
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<td>1.13</td>
<td>-</td>
<td>6.0</td>
<td>Loose</td>
</tr>
<tr>
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<td>1.57</td>
<td>±</td>
<td>8.0</td>
<td>Firm</td>
</tr>
<tr>
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<td>60,91,86,292</td>
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<td>1.39</td>
<td>++</td>
<td>10.0</td>
<td>Loose</td>
</tr>
<tr>
<td>14</td>
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<td>5.00</td>
<td>1.12</td>
<td>±</td>
<td>7.0</td>
<td>Semi firm</td>
</tr>
</tbody>
</table>

* Each formulation comprises of one cit* (flavor producer) among other acid producing strains.

3.0 Suggested Readings


1.0 Introduction

India has very rich cultural heritage with diversified rituals, customs and foods and when it comes to traditional foods, milk and milk products find prominence among all. The indigenous milk products like burfi, khoa, paneer, dahi, misti doi, rabri, kulfi etc has their wide appeal and acceptance among general mass. So, food safety issue associated with these products now has become a matter of great concern to the food industry, regulatory bodies and the consumers. Assurance of both the safety and quality of food is the most important aspect of food production because of increased public awareness towards health care and changing food habits. Since perishable foods like dairy products are extremely vulnerable to microbial contamination during their processing, especially under tropical, humid and unhygienic conditions prevalent in third world countries like India, their microbiological safety against high risk food pathogens has always been a matter of considerable public health concern. In view of this, the microbiological quality and safety of these foods has to be ensured by rigorous testing and monitoring before they reach consumers. To achieve this target, appropriate sensitive and reliable analytical tools are required to quickly detect and enumerate these pathogens in such foods to ensure their safety and correct risk assessment. Food borne outbreaks have also highlighted the necessity of new improved, user friendly and cost effective diagnostics to enable effective monitoring of the foods especially in relation to high risk food borne pathogens such as E. coli O157:H7, Listeria monocytogenes, Staphylococcus aureus and Salmonella spp. during preparation and processing for human consumption. The conventional methods of identification and confirmation involving growth on selective medium, biochemical tests and immunological assays are extremely laborious, cumbersome, inconclusive and results are delayed considerably to make them virtually impractical for any follow up action. Recently, methods based on molecular biology have revolutionized the field of diagnostics with highly rapid and authentic techniques, foremost among all, is Polymerase Chain Reaction (PCR).

2.0 What is PCR?

Polymerase chain reaction (PCR) is a technique, which is used to amplify the number of copies of a specific region of DNA, in order to produce enough DNA to be adequately tested. This technique can be used to identify pathogenic bacteria in traditional dairy foods with a very high-probability. The process comprises three prominent steps of denaturation, annealing and extension. Initially, in this process, template DNA is added to a mix containing individual nucleotides, DNA polymerase, and synthesized sequences of nucleotides called
primers, which define what section of the DNA is to be amplified. The mix is then heated to nearly 100°C to denature the template. While annealing, the synthesized primers bind to their complimentary regions on the separated DNA strands. From there the DNA polymerase recognizes the primers as starting points and begins moving down the DNA strands, adding a complimentary nucleotide for each nucleotide on the template DNA. The end result is two new DNA molecules, each one single stranded before the primer and double stranded after the primer. When the mix is heated again, the new DNA strands melt, allowing primers to attach to the appropriate site, and the process continues until one decides enough amplification has been made. This shouldn’t take much time, since the amount of DNA is doubled each time the cycle is enacted. The amplified product is viewed for the formation of a specific product on agarose gel and the formation of specific band confirms the presence of a particular product and related pathogen. The PCR based methods are not only fast but also highly specific as they are based on the genetic makeup of the organisms.

2.1 Limitations of PCR

Although, PCR has hastened and authenticated the whole process of the pathogen detection, there are certain limitations still associated. The quantitation of the target is not possible using conventional PCR. Similarly, it is very difficult to detect the small number of target organisms due to its low dynamic range. The formation of non-specific product and post PCR contamination issues still remains to be addressed.

![Polymerase Chain Reaction Diagram]

**Fig. 1. Polymerase Chain reaction: A schematic presentation**
3.0 Real Time PCR

The most recent arsenal in the war against food borne pathogens is Real Time PCR, also known as quantitative PCR or q-PCR. Real Time PCR incorporates fluorescence creating the ability to directly measure and quantify the amplification reaction. Reactions are characterized by the point in time during cycling when amplification of a PCR product is first detected rather than the amount of PCR product accumulated after a fixed number of cycles. The specific primers and probes designed, bind to the target DNA of interest and produce fluorescence. Real Time PCR modifies the technique in a way that reduces the chance of false positives observed in traditional PCR by 99.9%. Even a single copy of target DNA can be detected due to high dynamic range. There are around six different chemistries involved in the real time identification i.e. Intercalating Dyes, Molecular Beacons, TaqMan probes (Hydrolysis probes), FRET Probes, Scorpion Probes and Amplifluor Probes.

3.1 Intercalating Dyes:

These dyes non-specifically bind to the double stranded DNA and fluoresce on excitation by appropriate source. One of the most commonly used dyes is SYBR Green. They need melt curve analysis for the detection of specific target sequence. These dyes have been extensively used for the detection of different potential pathogens by different investigators like Cady et al (2005).

3.2 5' Nuclease Assay:

This chemistry is based upon the 5' exonuclease activity of DNA polymerase and has been extensively used by different investigators for the detection of various pathogens, e.g Salmonella detection by Massi et al (2005)

3.3 Hybridization probes:

Hybridization probe or FRET (Fluorescence Resonance Energy Transfer) probe system involves two separate sequence specific oligos, which are fluorescently labeled. The upstream probe has a donor at 3' end and the downstream probe has an acceptor molecule at 5' end. Hybridization probes have also been used for detection of high-risk food pathogens (Nguyen et al 2004).

3.4 Scorpion probes:

Scorpion probes involve a hairpin loop which is linked to the 5' end of a primer via PCR stopper. After extension of primer during PCR amplification, the specific probe sequence is able to bind to its complementary sequence within the same strand of DNA. This hybridization event opens the hairpin loop so that fluorescence is no longer quenched and increase in signal is observed.

3.5 Amplifluor Technology:

This technology deploys Amplifluor primer consisting of 5' intracomplementary sequence labeled with reporter and quencher. The sequences 3’ to the hairpin loop is the target specific primer region. Rodriguez-Lazaro et al (2004) used amplifluor technology for detection of Listeria monocytogenes.
3.6 Molecular Beacons:

Molecular Beacons are DNA hybridization probes that form a stem-loop structure. When a molecular beacon hybridizes to the specific target template, the hairpin structure is broken and reporter dye is no longer quenched. The fluorescence thus produced is proportional to target concentration. Patel et al, (2006), have recently, reported use of molecular beacon for the detection of the Salmonella.

4.0 Indian Scenario

The situation in India is quite grim when it comes to the assurance of the microbiological quality of the dairy products. The organized dairy sector like co-operatives and MNC’s are still sticking to the cultural and biochemical profiles to confirm the presence or absence of the potential pathogens. The fast and more authentic molecular techniques are still to be adapted by the dairy sector. But in the unorganized dairy sector, the situation is worst as no quality assurance and preventive measures are employed. There are no microbiological standards of indigenous products as well as analysis of these dairy products manufactured in the unorganized dairy sector, which renders consumers at a greater health risk and aggravate the chances of food-borne outbreaks. On the other hand, molecular techniques based on PCR and Real Time PCR have been in vogue in the developed countries for the detection of potential pathogens in the dairy based products. The situation in Indian context becomes grimmer as there is no stringent regulation to compel the domestic producers to meet the prescribed microbial quality standards. In such a cloudy scenario, a PCR / Real Time PCR instrument in a referral lab could be very handy and helpful to ensure the presence / absence and enumeration of the potential pathogens in dairy products. The samples could be sent to the referral lab and their microbiological status regarding the absence / presence of the potential pathogens and there number be established before their export. This quick technique for the detection and enumeration of pathogens will also help the regulatory authorities to come up with the more stringent food standards.

The first PCR based kit for the detection of E. coli O157:H7 and Listeria monocytogenes was developed in our lab (DBT sponsored project). The developed kits were applied on the various traditional products like kulfi and paneer and were found to be highly specific and sensitive. Presently in our lab, we have an ongoing project for the development of the Real Time PCR based kits for the detection of the potential food pathogens (MFPI sponsored). We are deploying both, non specific (intercalating dyes) as well as specific (molecular beacon) chemistries for the assay development (MFPI Sponsored).

5.0 Conclusion

Detection of food pathogens in dairy products has been obviously benefited by the sensitivity and rapidity that PCR has brought. However, advent of Real Time PCR has further improved the role of PCR in high-throughput environment by adding a detection system capable of enormous dynamic range, homogeneity of amplification and detection, and the ability to genotype an amplified nucleic acid without the need for additional steps. Real Time PCR is and will continue to consolidate fluorogenic nucleic acid amplification as a routine and incredibly powerful tool for the laboratories of tomorrow, especially food labs.
6.0 Suggested Readings


