CHAPTER 2
LITERATURE REVIEW

The review of literature pertaining to the topic of present study has been reviewed in this chapter. Since the published information about Chhana jalebi is scanty, the literatures of closely related products, various preservatives, packaging material and techniques were included in this chapter.

2.1 INGREDIENTS

2.1.1 Chhana

Chhana is a heat and acid coagulated mass obtained from milk followed by draining of whey. It constitutes the base and the filler material for various Indian milk sweets like rasogulla, sandesh and gulabjamun etc. Its preparation is mainly confined to some specific sectors, largely in the Eastern parts of India. However Chhana based sweets are gaining popularity in other parts of country. India’s total production of Chhana is estimated at 200,000 tonnes per annum and the value of Chhana based sweets, around Rs. 70,000 million [6].

Traditionally Chhana is made by heating the milk directly in a large utensil over stove. When milk reaches near boiling, heating is stopped. During heating, milk is being stirred continuously to avoid burning. To the hot milk, sufficient amount of coagulant (usually dilute acid solution or sour whey) is added and mixed uniformly by gentle stirring. When the coagulation is completed, whey separates out. Coagulated mass is allowed to settle down and then the contents of the utensil are poured over a piece of muslin cloth. The cloth containing the coagulum is hung on to allow the whey to drain off completely. The resultant product is called Chhana.

There is no difference between paneer and Chhana. Chhana/paneer means the product obtained from cow or buffalo milk or a combination thereof by precipitation with lactic acid or citric acid. It should contain not more than 70% moisture and its milk fat content should not be less than 50% of the dry matter basis [21].
### Table 2.1 Classification of Indigenous Channa based milk sweets

<table>
<thead>
<tr>
<th>Category</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rasogulla and its derivatives</td>
</tr>
<tr>
<td>Cooked Channa-juicy products</td>
<td>• Rasogulla- boiled in sugar syrup</td>
</tr>
<tr>
<td></td>
<td>• Rasmalai- boiled in syrup and transferred to sweetened condensed milk</td>
</tr>
<tr>
<td></td>
<td>• Rajbhog- boiled same as rasogolla, but stuffed with khoa, spices and cardamom</td>
</tr>
<tr>
<td></td>
<td>• Chamcham- boiled same as rasogolla but shaped cylindrical and decorated with grated khoa</td>
</tr>
<tr>
<td></td>
<td>• Danadar- boiled in very thick, almost crystalline, sugar syrup.</td>
</tr>
<tr>
<td>Uncooked Chhana</td>
<td>Katchagulla</td>
</tr>
<tr>
<td>Cooked Channa -dry products</td>
<td>Sandesh- medium moisture content Koda pak sandesh-very low moisture content.</td>
</tr>
<tr>
<td>Fried Channa pieces coated with sugar</td>
<td>Channa 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 Gulabjamun, langcha, kalajam, Channa 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>

Source: Verma et al., (2006) [22]

### 2.1.2 Maida

Maida means the fine product made by milling, grinding clean wheat free from rodent hair and excreta and bolting or dressing the resulting wheat meal. It shall conform to the standard given in Table 2.2. Starch products like maida and suji
(semolina) serve as binding agent in the production of the Channa podo. They hold moisture to give the taste of the product and bind other ingredients for the formation body and texture of Chhana podo. Maida and suji are tried at 5 and 10% levels of Chhana podo so as to Check the effectiveness of these binding agents on the sensory characteristics of the product. Chhana podo with 5% suji resulted in a granular texture whereas with maida, it gave a smooth surface area. This is because of the difference in the grain size of maida and suji. Both maida and suji could be used as additives to obtain an acceptable quality podo with spongy texture. Overall acceptability score indicated that incorporation of 5% suji resulted in best quality product among all other combinations [23].

Table 2.2 Specifications of maida

<table>
<thead>
<tr>
<th>Composition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>≥ 14.5% (when determined by heating at 130-133°C for 2 hr)</td>
</tr>
<tr>
<td>Total ash</td>
<td>≥ 1.0%</td>
</tr>
<tr>
<td>Ash insoluble in dilute HCl</td>
<td>≥ 3.1%</td>
</tr>
<tr>
<td>Gluten</td>
<td>≤ 7.5%</td>
</tr>
<tr>
<td>Alcoholic acidity</td>
<td>≥ 0.12% expressed as H₂SO₄ (on weight basis with 90% alcohol)</td>
</tr>
</tbody>
</table>

Source: FSSAI (2010) [21]

2.1.3 Sugar

Sugar is used as an ingredient in many of the sweet products. It is chemically known as sucrose, a disaccharide of glucose and fructose. It is well known for its role in human nutrition. Apart from giving taste to food, it also increases the calorific value of the food.

Pure sucrose is a fine, white, colorless, crystalline powder with a pleasing sweet taste. It is commercially produced from juice of sugar cane or sugar beet. Other minor commercial source is sweet sorghum.
Sucrose is ubiquitous in food preparations due to both its sweetness and functional properties. It is important to structure of many foods including breads and cookies, cakes, pies, candies, ice cream and also helps in preservation. Sucrose is an easily assimilated macro nutrient that provide quick source of energy to the body provoking a rapid rise in blood glucose upon ingestion.

White sugar (commonly known as sugar) is obtained from sugar cane or sugar beet. It shall be free from dirt, filth, iron filings and added coloring matter. It shall also confirm to the following standards namely:

<table>
<thead>
<tr>
<th>Composition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>≥ 0.5% by weight (when heated at 105±1°C for 3 hr)</td>
</tr>
<tr>
<td>Sucrose</td>
<td>≤ 98.0% by weight</td>
</tr>
<tr>
<td>Extraneous matter</td>
<td>≥ 0.1% by weight</td>
</tr>
</tbody>
</table>

Source: FSSAI (2010) [21]

2.1.4 Baking powder

Ghosh et al., (1984) [24] reported that a high level of baking powder resulted that soapy taste, extra porosity, big air cells and cracking of gulabjamun balls during frying. Low levels of baking powder caused hardness resulting in lesser absorption of sugar syrup and very close texture.

2.2 METHOD OF MANUFACTURING

In traditional manufacturing production process of Chhana, a small amount of boiled milk is poured to a vessel. The necessary quantity of coagulant particularly, previous day’s whey is added to the hot milk and stirred with a wooden laddle till the coagulation is complete. The vessel contained coagulated 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 [6].

2.3 PRINCIPLE INVOLVED IN CHHANA MANUFACTURING

Chhana making involves destabilization of casein by adding mild acid to milk at comparatively higher temperature. Mild acid affects the casein stabilization directly by disturbing the ions carried by the molecules and indirectly by releasing the calcium ion from colloidal calcium-caseinate-phosphate complex. These destabilization of calcium-caseinate-phosphate complex results in formation of large structural aggregates where milk fat, serum proteins and other constituents get entrained [22].

2.4 CHHANA BASED PRODUCTS

2.4.1 Chhana jhili

Chhana jhili is a popular product of Orissa. It is fried sweet product made from Chhana. It is prepared by mixing Chhana in the batter of maida and sooji. It is then made into specific shape and fried in oil, and then it is soaked in sugar syrup. It is irregular in shape, golden to brown in color, has soft body, spongy texture and caramelized cooked flavor.

Dyuthi (2009) [25] standardized the process of manufacturing Chhana jhili. Moisture content of the batter was optimized to be 55-60%. Frying temperature was optimized at 150-160°C for 10-15 minutes. Optimum sugar syrup soaking condition was found to be at 70°C in 40-45% sugar syrup for 3 hrs. Chhana jhili made by 4% fat in milk showed better result than 3% fat in milk. Suji at 15% level in the batter was added which gave good texture to the product. It resulted in spongy and soft product.

Chhana jhili contained 42.07% moisture, 9.41% fat, 8.94% protein, 21.2% sucrose, 0.5% ash, and 17.13% other carbohydrates [25]. The product packed in stand by pouch with 1000 ppm sorbic acid showed maximum shelf life of 20-25 days at room temperature. The samples added with preservative and kept in proper packaging material showed longer shelf life in both refrigerated and room temperature when compared to control, hot filling pouches with and without preservative samples.

Ghosh reported that Chhana jhili composition was Chhana 85-95%, maida/suji 5-15% and sugar syrup concentration 35-45%. Shape was irregular and their
composition was total solids 40-50%, fat 9-10.5%, protein 7-8.5%, ash 07-0.8% and carbohydrates 25-30.5% [26].

2.4.2 Pantua

Pantua has its origin in eastern parts of India. It is similar to gulabjamun except pantua dough is mainly made of a Chhana and maida whereas gulabjamun is made with khoa and maida. Traditionally, Chhana is mixed with about 1% baking powder and 12% wheat flour. The mass is kneaded into uniform dough, portioned and rolled into balls between the palms. The balls are deep fried in ghee in a shallow pan till they are deep brown in color. The fried balls are dipped in 60% sugar syrup for a few hours before serving [6].

A method of manufacture of pantua has been mechanized wherein cow milk Chhana (58% moisture) and dhap type khoa (40% moisture) was used. The final formulation contained Chhana (50%), khoa (40%), maida (3%), arrowroot (3%), suji (3%), ground sugar (0.7%) and baking powder (0.3%) [27].

Nath (1992) [27] quoted a recipe for pantua preparation in which 300 g of Chhana, 300 g khoa, 35 g maida and ½ teaspoon baking powder. A method for pantua preparation and suggested the following ingredients. Khoa 300 g, Chhana 300 g, maida 35 g, sugar 1 kg, water 1 kg, ghee, 1 kg, baking powder, ½ spoon. The functions of maida and baking soda are similar to those in case of gulabjamun. Traditionally khoa and Chhana are broken into bits and kneaded with mixture of dry ingredients. Moisture content in dough or batter has an influence on the body and texture as well as final quality of the product. Overall sensory scores increased with increase in moisture content of Chhana in pantua preparation. Pantua made from Chhana with about 58% moisture possessed all desirable sensory attributes and use of Chhana with lower than 55% moisture resulted in hard, chewy and dry product. The mass is kneaded into uniform dough, portioned and rolled into balls between the palms (2.5 cm diameter and 12 g weight). The balls are deep fried in ghee (120°C) in a shallow pan till they are deep brown in colour. The fried balls are dipped in 55 - 60% sugar solution for about 4 hr at about 60°C [6, 27].

The gross chemical composition of pantua is total solids 59.7%, fat 15.5%, protein 8.7%, ash 0.67%, sucrose 27.1% and other carbohydrates 7.7%. Nath (1992)
reported that the polystyrene cups are best for packaging of pantua. It had a shelf-life of 7 and 4 days in polystyrene, LDPE pouches respectively.

2.4.3 Khoa

Khoa has a short shelf life i.e. 2 - 5 days under ambient conditions and 16-18 days under refrigerated conditions. The spoilage of khoa is mainly because of mould growth on the surface. Several studies have been reported for enhancement of shelf life of khoa by using suitable packaging materials, preservatives and packaging systems. De and Ray (1952) [29] used butter paper for wrapping of khoa which resulted in a minor increase of keeping quality at 20-22°C. Jalil et al., (1963) [30] suggested that the shelf life of khoa wrapped in sodium propionate treated butter paper was found to increase up to 5 days at room temperature and 20 days at 5 °C. However, its shelf life was extended up to 45 days at 5°C when wrapped in butter paper treated with 30% solution of potassium sorbate [31] reported by Ghodekar et al.,(1980) [31] and Kumar et al., (1975) [32] studied the influence of polyethylene and laminated pouches (2, 3 and 4 ply) on the keeping quality of khoa. Samples packed in parchment paper and polyethylene remained acceptable up to 5 days at 37°C and 14 days at 8±1°C. The shelf life of the product was increased to more than 75 days at 20°C. Four-ply laminates (paper/poly/aluminium/poly) provided maximum protection followed in descending order by 3-ply and 2-ply packs.

Goyal and Srinivasan (1988) [19] further suggested new packaging materials like LDPE laminate in conjunction with paper/ aluminum foil or metalized polyester provides better protection against microbial attack than metal cans and parchment paper. Application of preservatives on the surface of such packaging materials could be quite useful in enhancing the keeping quality of khoa. Sharma et al., (1978) [33] did not observe any additional increase in the shelf life of khoa packaged in radio-sterilized pouches. They inferred that packaging material does not contribute significantly to the microbial contamination, because of plastic films that are processed at a temperature of about 110°C. Thus work done on the shelf life enhancement of khoa so far indicates that by using packaging materials with high barrier properties with and without preservatives, it is possible to enhance the keeping quality of khoa.
2.4.4 Khoa jalebi

Nawale Prateek (2010) [13] standardized the process of manufacturing khoa jalebi. Moisture content of the batter was optimized to be 45-50%. The combination of khoa, arrowroot and toukir in the proportion of 100:25:5 parts gives best sensory scores. Frying temperature was optimized at 160-160°C for 2-3 minutes. Based on the sensory analysis, optimum sugar syrup soaking condition was found to be at 40°C in 60% sugar syrup for 2-3 minutes.

Khoa jalebi contained 25-32% moisture, 9.19% fat, 6.05% protein, 18% sucrose, 11.5% lactose, 1.38% ash, 27.73% carbohydrates, pH 6.52 and acidity 0.88%. The product packed in LDPE pouch and multilayered pouches and stored at room temperature. The LDPE and multilayered pouches contained samples showed maximum shelf life of 8 days and 10 days at 30°C respectively.

Pagote and Rao (2009) [34] reported that khoa jalebi is very tasty and sweet delicacy among all types of jalebi and widely preferred for eating during fasting days in Maharashtra and parts of Madhya Pradesh and Rajasthan. For making khoa jalebi, khoa and arrowroot are mixed to form batter. The batter is then passed through the hole of cloth to give a coil like shape and put in hot oil for deep frying till getting light to dark brown color. The fried sample is then dipped in warm sugar syrup for few minutes before serving.

Information on khoa jalebi is being collected as a part of survey work being conducted by NDRI, Bangalore [34]. From the information collected it was reported that the jalebi pieces processed brown color from higher shade to darker shade. The jalebi pieces have moist appearance because of sugar syrup. The interior of jalebi pieces were lighter and softer than the crust portion. The body of the khoa jalebi was firm, but slightly juicy with syrup oozing out when chewed but not to the extent observed in traditional jalebi. The flavor was described as pleasantly sweet and slightly caramelized.

The ingredients used in the preparation of khoa jalebi are khoa, arrowroot and toukir which are mixed to form batter. The review of literature shows that there is not much information available on khoa jalebi. Only the market survey is conducted to gather information. Variations were also observed in the ingredients used for khoa jalebi preparation and the method adopted for production process varied from halwai to
halwai. Hence there is need for characterization and process optimization for the preparation of jalebi [10].

Kumari et al., (2012) [35] reported that khoa jalebi, is a unique and popular khoa based sweet in Central part of India, prepared from khoa and tikhur. For optimizing the proportion of tikhur, khoa and soaking time of tikhur was varied from 20 to 60 g/100 g of khoa and 2 to 10 hr respectively using central composite rotatable design. Prepared jalebi samples were evaluated for fat content, Sugar Syrup Absorption (SSA), hardness and sensory parameters. All these parameters were significantly (p<0.05) influenced by varying tikhur in relation to khoa. The effect of soaking time on fat content, colour, taste and Overall Acceptability (OA) scores of product was non-significant (p< 0.05) whereas other parameters were significantly influenced. Optimization by response surface methodology showed that 47 g of tikhur per 100 g khoa and soaking time of 5.9 hr gave desirability index of 0.79 and OA score of 7.70 out of 9.0 on hedonic scale which was comparable with market sample showing OA of 7.67.

### 2.4.5 Gulabjamun

Gulabjamun is a khoa based sweet popular throughout the Country. Originally it was made with khoa and maida. It has light brown to dark brown colour with sweet and slightly cooked flavour. The body of gulabjamun is soft, slightly spongy and granular with oval to spherical shape [24]. In the recent years, gulabjamun mix has become popular among consumers mainly because of convenience in the preparation procedure. However, there is a difference in the quality of gulabjamun made from khoa and from the ready mixes.

In gulabjamun manufacture, the main ingredients used are khoa, maida and baking soda. De (1952) [29] reported a recipe of gulabjamun with 300 g khoa, 35 g maida and ½ tea-spoon of baking powder. Since khoa balls are fried in hot oil, the moisture from the interiors of the balls has to diffuse out to the surface. This is faster only when the body of the khoa is porous. Baking powder used makes the body of the khoa porous and facilitates moisture diffusion and hastens the frying rate. Since the moisture travels through the porous mass, there is a chance of breakage of the structure, so to withstand the effect of porosity caused by baking powder and binder is required, which is normally maida. Extent of maida depends on several factors especially type of
khoa used. It varies from 10-30% of khoa [24, 36-38], or semolina can also be used at 10% [39].

The khoa and other ingredients are thoroughly kneaded to obtain the smooth dough. Desired moisture level in gulabjamun dough has been reported to be 60±2% [39]. The dough is made into balls 15-25 g size and deep fried ghee or vegetable oil at 125-140°C for about 7-20 min till golden brown colour is attained [24, 38-40]. The frying rate is so maintained that the light brown colour is developed gradually which is an indication of optimum moisture evaporation. After frying the khoa ball are soaked in sugar syrup for about 4 hours. The optimum concentration of sugar syrup is 50-60% at 60-70°C [24, 36, 38, 41].

Dharam Pal et al., (2007) [7] reported that the gross chemical composition of gulabjamun varies widely depending on numerous factors such as composition and quality of khoa, proportion of ingredients, sugar syrup concentration etc. The composition of gulabjamun of drained weight was: moisture 25-35%, fat 8.5-10.5%, protein 6-7.6%, ash 0.9-1% and total carbohydrates 43.0-48.0%. Sharma and Zariwala (1978) [33] reported that the moisture content of gulabjamun varied from 22.2 to 41.8%, fat from 5.0 to 8.0%, protein from 0.0 to 3.4% and sucrose from 30.5 to 41.3% . Chaurasia (1987) [43] analyzed the samples of gulabjamun collected from Karnal market and those prepared in the laboratory for gross chemical composition. The average values were found to be moisture 32.20% and 30.63%, fat 8.11% and 8.73%, total protein 5.24% and 5.32%, total carbohydrates 53.53% and 54.40% and ash 0.92% and 0.93% for market and laboratory samples.

Gulabjamun is normally packaged along with sugar syrup. Dharam Pal (2000) [42] reported that the shelf life of gulabjamun at ambient temperature in sugar syrup was 5-7 days. Tin can is the most suitable package for this group of products [6]. Chaurasia (1987) [43] reported that the tin containers are the best for packaging of gulabjamun. Gulabjamun had a shelf life of 20, 16 and 12 days in tin cans, laminates and polystyrene cups, respectively at room temperature [43]. Packing of rosogolla in 0.4 mm thick cans with inside food grade epoxy phenolic compounds lacquering has shown shelf life of 60 and 140 days when stored at 30°C and 7°C. To reduce the expense in tin cans rosogolla and gulabjamun are now being packed in metallised polyester or HDPE made “standy pouches”. However, as compared to tin can the shelf life of the products
are much shorter, with a maximum up to 28 days even at refrigerated condition of storage [20].

2.4.6 Chhana Podo

Chhana podo is baked Indian delicacy made by mixing Chhana with maida/suji (ground wheat flour) and sugar and then baked in a manner similar to baking of cake. The puffed, brown colored crust product has a spongy, soft texture. Milk has to be standardized to 4-4.5% fat, maida/suji is recommended at 5% level, while sugar is required at levels ranging from 25-35% and water may be used at the rate of 30% by weight of Chhana. The product is baked at 150-200°C for 50-80 minute [44-46]. It has been reported that shelf life of Chhana podo has been extended up to 8 days at 37°C by the incorporation of potassium meta bi-sulphite and potassium sorbate [47].

2.4.7 Chhana powder

Chhana powder was producing through roller, tray and spray drying processes [48]. Sandesh can be prepared by reconstituting Chhana powder in to Chhana. However, rasogulla could not be prepared as balls get loosen their structure during boiling in sugar syrup. Generally, this product has a shelf-life of 2 and 4 months under air tight and gas packed conditions respectively.

2.4.8 Sandesh

It is the most popular Chhana-based sweet in Eastern parts of India, especially West Bengal. Utilization of Chhana for sandesh preparation is higher than all other Bengali sweets. It is reported that around 80% of Chhana produced in Kolkata is converted into sandesh [6]. Chhana produced by using citric acid than other acids for the sandesh production. It is rich source of milk proteins, sucrose fat and vitamins. It has a smooth texture and firm body.

2.4.9 Rasmalai

It is Chhana based sweet produced from suspending rasogulla in sweetened condensed milk. The one kg of milk is evaporated in open pan till it reaches one-half its original volume (500 g). At this stage 4% of sugar is added. At slow heat, evaporation is continued till the content is become one-third of its original volume (350 g). Then
rasogulla is added to it and heating continued for 2-5 min. The container is removed from the heating and the content is allowed to cool till it reaches to room temperature and stored at refrigerated conditions. Since the product has limited keeping quality, it should be consumed within 3-5 days [22].

2.4.10 Chhana - murki

Chhana murki is another Chhana based sweet. Mostly buffalo milk is preferred for the production of this sweet. Since there is no standardized method for production of this product, large variations are observed in its sensory characteristics, physico-chemical and microbiological quality. Chhana, sugar, water and a few drops of flavor are used in its preparation [22].

2.4.11 Cham-cham

Cham-cham is also one of Chhana based sweet. Production of this product is same as rasogulla. Instead of making round balls it is given cylindrical shape in the preparation. This product is produced by smearing grated khoa or coconut powder. Yield, composition, and shelf life of the sweet is almost similar to that of rasogulla.

2.4.12 Khirmohan

Khirmohan is also one of Chhana based sweet variety which is popular in Eastern India. Chhana is kneaded along with 1-4% wheat flour into smooth dough, portioned and rolled into small balls. Then the balls are flattened to round shape and processed like rasogulla. After cooking, these balls are dipped in concentrated milk, removed and smeared with grated khoa.

2.4.13 Chhana based table spreads

There are few attempts made in this area of product. Production process was initiated by Tewari (1991) [49]. Chhana is acting as base material for the production of Chhana-spread. Chhana was made into small pieces and made in to paste by adding water and mixing by using mixer. The 1-1.5% of salt was added during mixing. Acidifying agent was also added to lower the pH from 5.1 to 5.0. A low-fat sweetened dairy spread was also developed by Babubhai (1999) [50]. Chhana and skim milk powder (SMP) was played as source of protein in this product. Protein-enriched table
spread was developed by Reddy et al., (2003) [51] by 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 warring blender at 15-20°C for about 30 min to yield a homogenous mass. Salt was added at the rate of 2% (w/w). Based on the various physico-chemical and sensory attributes, use of 40% of Channa was reported to be best suited for the preparation of spread.

2.5 PHYSICO-CHEMICAL AND OTHER CHANGES DURING STORAGE

2.5.1 Changes in khoa

Various chemical changes take place in khoa during storage such as glycolysis and proteolysis. The titratable acidity of fresh khoa is 0.720% which increases during storage because of glycolytic reactions. The average pH of fresh khoa was 6.30 which decreased steadily reaching a level of 6.10. Khoa is reported to contain a variety of microorganisms such as \textit{Staphylococci, Conforms, Enterococci}, as well as yeasts and moulds [52-53]). Khoa normally contains \(49 \times 10^3\) g microorganisms and increases to \(125 \times 10^6\) g which cause spoilage. Use of potassium sorbate at 0.3%, reduced this number to \(38 \times 10^3\) g. Yeast and mold growth was also retarded by potassium sorbate. It markedly reduced the rate of growth of yeast and mold count, which took three fold as much time (12 days) to reach the level of control samples (4 days) at 30°C.

2.5.2 Changes in gulabjamun

Gulabjamun is normally stored dipped in sugar syrup. During the storage, the spoilage is caused mainly because of yeast and mold growth. As a result, the gulabjamun tastes sour and the syrup becomes viscous. However, the shelf life of gulabjamun is limited more by microbial changes than textural changes. No detailed studies have been reported on the spoilage mechanism of gulabjamun [54].

2.5.3 Changes in pantua

Pantua like is normally eaten or stored along with sugar syrup. During the storage, the spoilage is caused mainly because of yeasts and mold growth. As a result, the pantua tastes as sour and the syrup becomes viscous. However, the shelf life of pantua is limited more by microbial changes than textural changes. No detailed studies have been reported on the spoilage mechanism of pantua [27].
2.6 FACTORS AFFECTING THE QUALITY OF THE PRODUCT

2.6.1 Moisture content of the batter

Moisture content of dough or batter has an important role in the quality of the product. Overall sensory scores increased when increase in moisture content of Chhana in pantua preparation. Pantua made by Chhana with about 58% moisture possessed all desirable sensory attributes and use of Chhana with lower 55% moisture resulted in hard, chewy and dry product. Desired moisture level in gulab jamun dough is reported to be 60% by Prajapati et al. (1991) [39] whereas Rajorhia (1989) [54] reported that the moisture level of gulab jamun could be increased by increasing the quantity of water per binding agent level during dough making.

In case of rasogulla, about 55-58% of moisture level in Chhana is found to be optimum for good quality and which shows a good shape, soft body and maximum spongy texture. If the moisture level is below 50%, then harder body and less spongy texture was observed. Moisture content of 60% shows a rasogulla with softer body, flattened shape and uneven texture [55].

2.6.2 Proportion of binder in dough/batter

Addition of maida and arrowroot in equal amounts (3% each) resulted in pantua samples with good flavor and body. It was also observed that higher proportion of either maida or arrowroot (flour strach) significantly lowered sensory scores of the product. Addition of 3% suji was found to be significantly acceptable whereas pantua with less than 3% suji produced slightly hard and dry body with low sugar syrup absorption and retention capacity. Use of 5% suji resulted in soggy and unduly soft product [27].

Srinivasan and Ananthakrishnan (1964) [36] suggested that addition of 75-100 g maida for 350-375 g khoa however Gill and De (1974) [37] recommended 35 g of maida for 300g of khoa whereas Ghosh et al. (1984) [24] reported 25 g of maida for 75 g of khoa foe gulabjamun preparation. Prajapati (1991) [39] found that incorporation of 10% suji in khoa produced in best quality gulabjamun. Rangi et al., (1985) [38] reported that gulabjamun prepared with 20% refined flour and 80% khoa imparted excellent consumer acceptability. Increasing flour to 30% showed hard texture whereas 10% shows the product become too soft. Aneja et al., (2002)
[6] recommended maida in a proportion of 10% of khoa for gulabjamun production.

2.6.3 Frying temperature and time

A time temperature combination of 120°C for 20 minutes was found to be most suitable for pantua production. Frying at 130°C resulted in excessive browning. Frying at 110°C resulted in under cooking of pantua with dough taste and dull brown color [24]. Prajapati et al., (1991) [39] found that frying of gulabjamun at 170°C for 15-20 minutes resulted in good product with uniform brown colored surface whereas Rangi et al., (1985) [38] reported deep frying of gulabjamun at 150°C for 15 minutes for best results.

2.6.4 Sugar syrup concentration

Sugar as a preservative is well known in food industry. In liquid state, it is stable to yeast growth in the concentration range of 66% and above. Date et al. (1958) [41] observed that 50-55% concentration of sugar syrup was optimum level. Srinivasan and Ananthakrishnan (1964) [36] reported that syrup concentration is likely to influence physico-chemical quality of gulabjamun. They recommended that sugar syrup concentration of 60% has most desirable. Ghosh et al., (1984) [24] also recommended that syrup concentration of 60% at a temperature of 60°C was most desirable for gulabjamun prepared from mix powder.

2.6.5 Sugar syrup soaking conditions

Nath (1992) [27] observed that 55% sugar syrup and 4 hr of soaking time is optimum for making of pantua. A concentration of 50% was considered not enough and 60% level was too sweet. Date et al., (1958) [41] found an optimum sugar syrup concentration of 50-55% for rasogulla. Srinivasan and Ananthakrishnan (1964) [36] suggested that syrup concentration is likely to affect the physical and chemical of the gulab jamun and recommended 60% as the best. Prajapati (1991) [39] suggested 50-60°C temperature as the optimum for soaking of gulabjamun. Ghosh et al., (1984) [24] suggested 60% syrup at 60°C whereas Rangi et al., (1985) [38] reported that 50°Brix at 70°C for 4 hr for soaking of gulabjamun showed best sensory report.
Bhattacharya and Des Raj (1980) [55] showed that rasogulla packed in UV treated polyethylene pouches and stored at refrigeration temperature, room temperature (5-20°C) and 37°C showed acceptability up to 18, 6 and 3 days respectively. They recommended refrigerated temperature which ranged from 4-6°C and 8-12°C for storing rasogulla made from cow and buffalo milk respectively.

2.7 PERMITTED PRESERVATIVES IN DAIRY FOOD PRODUCTS AND THEIR PROPERTIES

Preservatives are defined as 'substance capable of inhibiting, retarding or arresting the growth of microorganisms or of any deterioration resulting from their presence or of masking the evidence of any such deterioration'. They do not therefore include substances which act by inhibiting a chemical reaction which can limit shelf life, such as the control of rancidity or oxidative discoloration by anti-oxidants. Neither does it include a number of food additives which are used primarily for other purpose but have been shown to contribute some antimicrobial activity. Preservatives may be microbicidal and kill the target organism or they may be micro biostatic in which case they simply prevent the growth.

According to FSSAI (2010), preservative means a substance which when added to food, is capable of inhibiting, retarding or arresting the process of fermentation, acidification or other decomposition of food. Preservative shall be divided into two classes namely, class I preservatives and class II preservatives. Class I preservatives include common salt, sugar, dextrose, glucose (syrup), spices, vinegar or acetic acid and honey etc. and their use in food is not restricted. Class II preservatives include benzoic acid including salts thereof, sulphurous acid including salts thereof, nitrates or nitrites of sodium or potassium in respect of food like jam, pickled meat, sorbic acid including its sodium, potassium and calcium salts, nisin, sodium and calcium propionate, methyl or propyl parahydroxy benzoate etc. and their use is restricted [21].

2.7.1 Potassium sorbate

It is considered as GRAS additive for food preservation [56]. This is an unsaturated fatty acid 2, 4 hexadienoic acid. It has the pH 4.8 and shows the same dependency activity it is active against yeast and mold [57].
The level of sorbate necessary for the preservation of a specific product depends upon a number of factors including the product composition (pH, moisture, etc.), the initial contamination level, and packaging and storage temperatures. The preservative cannot be used to mask poor quality products or poor handling practices.

According to Food Safety and Standards Regulations (2010) carbohydrate based and milk based sweets like halwa, mysore pak, boond, ladoo, jalebi, khoa, burfi, peda, gulabjamun, rasogulla and similar milk based sweets sold under any name may contain sorbic acid as a preservative level of 1000 ppm [21]. Bikash et al., (2007) [47] reported that shelf life of Chhana podo has been extended up to 8 days at 37°C by the incorporation of potassium metabisulphite and potassium sorbate.

Goel (1970) [58] found that addition of sodium metabisulphate at 0.07% maintained the organoleptic quality of rasogulla for 60 days at 30°C. Potassium metabisulphate also showed significant potential as preservative. In rasogulla, addition of potassium metabisulphite at 100 mg SO₂ per kg of sugar syrup extended the shelf life upto 6 months at 30°C in tin cans.

Study conducted by Kulkarni (1968) [60], showed sorbic acid and potassium sorbates are highly effective antifungal additives. It has proved its effectiveness shelf life extend of Indian sweet products like khoa and paneer etc. [53, 59]. Usually high to medium traditional Indian milk sweets get spoilage by surface contaminants like molds [57]. In burfi, the shelf life could be extended upto 190 days by incorporating 0.1% sorbates (w/w) during the last stages of manufacturing.

Sen and Rajorhia (1997) [56] reported that addition of 0.01% sorbic acid extended shelf-life of sandesh up to 6 days at 30°C and 56 days at 7°C temperature of storage. Sorbic acid 0.15% concentration was effective against microbial and deterioration up to 70 days and 7°C however it imparts own flavor defects of the product.

Potassium sorbate was the only permitted chemical that was found to exert maximum inhibitory effect on microbial growth and maximum accelerating effect on keeping quality. Its most marked effect was on yeast and mold count.
2.7.2 Sodium benzoate

According to Food Safety and Standards Regulations (2010) carbohydrate based and milk based sweets like halwa, mysorepak, boondi, ladoo, jalebi, khoa, burfi, peda, gulabjamun, rasogulla and similar milk based sweets sold under any name may contain benzoic acid as a preservative level of 300 ppm. It occurs naturally in cherry bark, cranberries and can be prepared synthetically for food use. Its anti-microbial property is very good and relatively strong acid and effective in acid foods. As a consequence is inhibiting the growth of yeasts and molds. Activity against bacteria is registered but they show greater variability in their sensitivity [57]. The acid form is less soluble. Therefore, potassium and sodium salts are used. They are most effective in pH 2.5-4.0. Often potassium salts are preferred than sodium salts [60].

2.8 FOOD PACKAGING MATERIALS AND THEIR PROPERTIES

It is 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 grease-proof 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.

Channa based sweets like sandesh, rasogulla, 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 rasogulla is packaged in tinplate cans, or in paperboards, dhak leaves, kulhads (earthen pots) etc. Canning of rasogulla is expensive and the other methods of packaging are unhygienic, inconvenient and unsuitable for outstation retail sales [9].

Products like gulabjamun, pantua and rasogulla are to be soaked with sugar syrup as it is very important to retain their shape and sensory characteristics. Tin can is the most suitable package for this group of products [6]. Chaurasia (1987) [43] reported that the tin containers are the best for packaging of gulabjamun. It had a shelf-life of 20, 14 and 12 days in cans, laminations and polystyrene cups respectively at room temperature.
Packaging of rasogulla in 0.4 mm thick cans has shown shelf-life of 60 and 140 days when stored at 30° and 7°C. To reduce the expense in tin cans, rasogulla and gulab jamun now being packed in HDPE containers. However, as compared to tin cans, the shelf-life of the product is much less, with a maximum upto 28 days even at refrigerated conditions of storage [20]. The shelf-life of rasogulla was observed to be 14 days when stored at 30±1°C and upto 28 days when stored at 7±1°C [61]. Aneja et al., (2002) [6] proved that gulabjamun showed a shelf-life of 30 days at 5°C when packed in polystyrene cups whereas it was 270 days at room temperature in lacquered tin cans.

The influence of various packaging materials such as polystyrene, metalized poly ester laminate and tin cans on shelf-life of rasogulla revealed that cans offered maximum shelf-life of 20 days at 30°C without the use of preservatives. A shelf-life of 60 and 90 days was achieved by preservation of rasogulla in 40 and 50% sugar syrup, respectively. Aneja et al., (2002) [6] reported a shelf-life of rasogulla for 6 months at room temperature when packed in lacquered tin cans. Other kinds of packaging materials which are generally used for dairy based sweets are cardboard boxes lined with butter paper, low density polyethylene pouches, polystyrene cups closed with aluminum foil, metalized polyester.

Most of the Indian sweets are packed by using cardboard boxes by halwais. Gulabjamun and rasogulla are commercially available in tin cans. Goyal et al., (2007) [62] conducted studies on other Chhana based products like rasogulla which showed a shelf-life of 6 months at room temperature in tin cans. Lacquered tin cans which are used now days in order to avoid corrosion are not popular among local halwais as they are very expensive. According to the reports of Bandyopadhyya (2006) [20], the shelf life of the product is not more in tin cans also, with a maximum of 28 days even at refrigerated conditions. In order to further increase the shelf life of the product, can also use gas flushing inside the packaging material. Nitrogen gas flushing is more popular. The CO₂ gas is also used to flush inside of the packages.

Food packaging materials are selected based on several considerations. Among them are oxygen barrier, water vapour barrier, transparency, thickness, mechanical strength and cost etc. Those possessing high values of oxygen transmission rate and
water vapour transmission rate are termed low barrier and those with low values of the above mentioned properties are termed as high barrier packaging materials.

### 2.8.1 Low barrier packaging materials

Ahvenainen and Raija (2003) [63] have conducted studies on several packaging materials with low barrier properties. The low-density polyethylene (LDPE), high density polyethylene (HDPE), linear low density polyethylene (LLDPE), polystyrene (PS), ethylene acrylic acid (EAA), parchment paper, butter paper, cardboard boxes, and co-extruded films fall under this category. Their properties are shown in table below:

#### Table 2.4 Permeability characteristics of low barrier packaging films

<table>
<thead>
<tr>
<th>Types of film</th>
<th>Water vapor transmission rate ( (WVTR) ) ( (g/m^2 \cdot 24 \text{ hr.} \cdot 38°C/90% \text{ RH}) )</th>
<th>Gas transmission rate ( (25 \text{ mic}/m^2 \cdot 24 \text{ hr. atm. at } 25°C) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 micron</td>
<td>Oxygen</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>LDPE</td>
<td>18.6</td>
<td>7750</td>
</tr>
<tr>
<td>Nylone-6</td>
<td>388</td>
<td>40</td>
</tr>
<tr>
<td>PS</td>
<td>108-155</td>
<td>3875-5425</td>
</tr>
<tr>
<td>EAA</td>
<td>22.3</td>
<td>4557</td>
</tr>
<tr>
<td>HDPE</td>
<td>4.6-10.0</td>
<td>2868</td>
</tr>
</tbody>
</table>

Source: Kumar (1991) [64]

### 2.8.2 High barrier packaging materials

High barrier materials are those which allow very little or almost nothing of water vapour and gases. Metalized polypropylene and polyethylene terephthalate (MET PET), ethylene vinyl alcohol (EVOH), moisture proof, heat sealable transparent film cellophane (MST CELLOL), moisture proof, PVDC coated on both sides transparent film cellophane (MXXT CELLO), polyvinylchloride (PVC), Polyvinylidenechloride (PVDC) fall under this category. Hence these are much suitable where foods have to
be preserved from microbial contamination and oxygen ingress [64]. Their materials are summarized in the table below:

**Table 2.5 Oxygen transmission rate of the high barrier materials**

<table>
<thead>
<tr>
<th>Types of film</th>
<th>Oxygen transmission rate (ml/m² 24 hr. atm. at 25°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flat</td>
</tr>
<tr>
<td>MET PET (12 micron)</td>
<td>&lt;1</td>
</tr>
<tr>
<td>MET PET/LDPE (50 micron)</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Source: Kumar (1991) [64]

**Table 2.6 Effect of folding and crumbling of the high barrier properties**

<table>
<thead>
<tr>
<th>Types of film</th>
<th>WVTR (g/m²) 24 hr. 38°C &amp; 90% RH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flat</td>
</tr>
<tr>
<td>MET PET (12 micron)</td>
<td>0.9</td>
</tr>
<tr>
<td>MET PET/LDPE (50 micron)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Source: Kumar (1991) [64]

**Table 2.7 Permeability characteristics of high barrier packaging films**

<table>
<thead>
<tr>
<th>Types of film</th>
<th>WVTR (g/m²) 24 hr. 38°C &amp; 90% RH</th>
<th>Gas transmission rate (25 mic/m² 24 hr. atm. at 25°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25 micron</td>
<td>Oxygen</td>
</tr>
<tr>
<td>PET</td>
<td>20.1</td>
<td>47-62</td>
</tr>
<tr>
<td>EVOH</td>
<td>22-59</td>
<td>0.5-20</td>
</tr>
<tr>
<td>MST CELLO</td>
<td>7.8</td>
<td>8</td>
</tr>
<tr>
<td>MXXT CELLO</td>
<td>7.0</td>
<td>3</td>
</tr>
<tr>
<td>PVC</td>
<td>3-40</td>
<td>124-465</td>
</tr>
<tr>
<td>PVDC</td>
<td>1.5-4.6</td>
<td>12-107</td>
</tr>
</tbody>
</table>

Source: Kumar (1991) [64]
2.9 STORAGE CONDITIONS

Bhattacharya and Des Raj (1980) [55] recommended refrigerated temperature which ranged from 4-6°C and 8-12°C for storage of rasogulla made from cow and buffalo milk, respectively. Goyal et al., (2007) [62] showed that rasogulla packed in polystyrene pouches and stored at refrigerated temperature (4°C), room temperature (5-20°C) and 37°C showed acceptability up to 18, 6 and 3 days respectively.

2.10 EPILOGUE

The Indian milk sweets enjoy mass appeal, give high profit margins and have high export potential. There is an urgent need to standardize indigenous dairy products to produce high quality with long shelf life. From the literature, it was found that no standardized production process for Chhana jalebi. Most of these products have been characterized for their chemical composition, sensory attributes, 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 so that organized dairies may adopt the same. The knowledge of these characteristics would contribute a great deal in standardizing scaled up methods for manufacture of these products. We need to generate basic data on these products which will help for designing of new equipments and packaging lines. Wide scope also exists for improving the shelf life of these products by employing newer preservation techniques, packaging materials and modern packaging techniques. In the present work, attempts were made to develop the standardized production process for Chhana jalebi and extend the shelf life by employing preservation techniques and modern packaging techniques.