CHAPTER - 2

Review of Literature
2.0 REVIEW OF LITERATURE

Chhana, a heat and acid-coagulated dairy product, serves as a base material and filler for a large variety of Indian sweetmeats like rasogolla, sandesh, chhum-chum, chhana murki, chhana podo, rassomalai, etc. Its production is estimated at 2 million tones valued at Rs.7000 million (Aneja et al., 2002) with tremendous marketing potential. However, chhana is mostly prepared from cow’s milk as it yields fine texture with velvety body, suitable for sweet making, which is not achieved by buffalo milk, as there are inherent differences in physico-chemical make up between cow and buffalo milk. Chhana produced from buffalo milk has been reported to be hard and greasy which cannot be used for rasogolla preparation. Since, buffalo milk constitutes more than 55% of total milk production (IDF, 2004) of India and dairy plants prefer to buy it because of its high total solids content. Therefore, attempts have been made to optimize process parameters to utilize buffalo milk for preparation of chhana suitable for sweet making. Some of the suggested measures include addition of sodium citrates (Jagtiani et al., 1960), dilution of buffalo milk with 20-30% water (Iyer, 1978; Rajorhia, 1987), coagulation at low temperature (Iyer, 1978; Verma, 1989), homogenization (Soni et al., 1980; Ahmed et al., 1981). However, these measures yield only limited success.

2.1 DIFFERENCE BETWEEN COW AND BUFFALO MILK

Buffalo milk and cow milk is composed of similar constituents, but distinctly differs in the level. The quantitative and qualitative differences of various milk constituents have been reviewed by Sindhu & Singhal (1988). Many workers (Saraswat, 1985; Oommen & Ganguli, 1973, Kuchroo & Malik, 1976, Ramamurthy, 1976, Kumar & Bhatia, 1994, Sindhu, 1998) have reported compositional aspects and the salt balance of buffalo milk.
2.1.1 Compositional Aspects

Buffalo milk, in general, contains higher level of fat, solid-not-fat, total solids, total protein and ash as compared to cow milk. It also contains higher quantity of calcium and magnesium and lower amount of citrate and phosphate as compared with cow milk. Further, the soluble forms of calcium, magnesium and citrates are lower in buffalo milk than in cow milk.

2.1.1.1 Milk Proteins

According to Sindhu (1998), the concentration of both, the casein and whey proteins are different in cow and buffalo milk. Buffalo milk contains higher caseins and whey proteins than cow milk. Whole of the caseins in buffalo milk is present in the micellar form, while in the cow milk it is only 90-95%. Casein micelles in buffalo milk is bigger (110-170 nm) as compared to only 70-110 nm in cow milk (Saraswat, 1985; Oommen & Ganguli, 1973). The voluminosity of the casein micelles of buffalo milk is 2.68-3.72 ml/g compared to 4.18 ml/g of cow milk casein. Similarly, the solvation (hydration) of casein micelles from buffalo milk is lower, 2.60-2.90 g water/g caseins compared to 3.48 g for cow milk (Kuchroo & Malik, 1976). Opacity of buffalo casein micelles is higher compared to cow milk casein. Buffalo casein micelles contain higher proportion of calcium and magnesium, but lower proportion of sialic acid and hexose.

2.1.1.2 Milk lipids

Sindhu (1998) reported that buffalo milk fat contains higher proportion of high melting triglycerides (9-12%) than cow milk (5.6%), and as a result, it is more solid in nature. Similarly, the proportion of butyric acid containing triglycerides is also higher in buffalo milk (50%) compared to only 37% in cow milk (Ramamurthy, 1976). As a consequence of higher proportions of butyric acid containing triglycerides, the emulsifying capacity of buffalo milk fat is superior to cow milk fat. Fat globules are bigger (4.15-4.6 μm) in buffalo milk compared to cow milk (3.36-4.15 μm). They are rendered chargeless at much higher pH (6.5-6.6) in buffalo milk compared to the same at pH 6.3 in cow milk.
(Rangappa, 1963). Reported buffalo milk fat as poor in free fatty acids (0.22%) than cow milk fat (0.33%). Concentration of unsaponifiable matter (392-398 mg/100 ml) is also less in buffalo milk compared to cow milk (414-450 mg/100 ml). Similarly phospholipids content of buffalo milk is also less (921 mg/100 ml) compared to cow milk (37.37 mg/100 ml).

2.1.1.3 Milk salts

Concentration of calcium and magnesium is higher in buffalo milk as compared with cow milk. On the other hand, concentration of sodium, potassium and chloride is similar. The content of colloidal calcium and magnesium per 100 ml in buffalo milk is 160 mg and 90 mg in comparison to only 80 mg and 30 mg in cow milk. The Ca/P ratio in buffalo milk is 1.8 and it is 1.2 in cow milk (Sindhu, 1998).

2.1.1.4 Other constituents

Lipase and alkaline phosphatase activity is less in buffalo milk (Kumar & Bhatia, 1994). The free amino acids are present in higher concentration in buffalo milk (0.44%) as compared to cow milk (0.15%).

2.1.2 Physical Properties

Sindhu (1998) reported that buffalo milk has higher specific gravity (1.0323 at 20°C), viscosity (2.245 cPa at 27°C), surface tension (45.50 dynes/cm at 20°C), acidity (0.16% as lactic acid), pH (6.7 at 20°C), oxidation-reduction potential (+0.310 volts), and thermal conductance (0.569 Kcal/hm°C at 37°C) compared to cow milk as 1.0317, 42.50 dynes/cm, 0.15%, 6.6, +0.258 volts and 0.46 Kcal/hm°C, respectively. The heat stability of buffalo milk (32.28 min at 130°C) in fluid state is similar to the heat stability of cow milk (31.82 min at 130°C). However, the heat stability of concentrated buffalo milk is significantly lower than the heat stability of concentrated cow milk. Owing to the differences in physical properties, milk from two species behaves differently on processing or manufacturing of various products.
2.2 PRODUCTION OF CHHANA

Traditional chhana is prepared by boiling cow or mixed milk in an iron pan using coal or firewood as fuel. Milk is allowed to cool at 80-85°C and coagulation is achieved in a small container by slowly pouring previous day's sour whey, while gently stirring with the help of a ladle. The process is continued until milk is precipitated in lumps, which settles at the bottom. The clear whey on top is filtered through a muslin cloth. Cow milk is preferred for chhana making because it yields a soft body and smooth textured product, which is suitable for chhana based sweets (De & Ray, 1954; Kundu & de, 1972; Gera, 1978; Soni et al., 1980; Bhattacharya & Des Raj, 1980).

Soni et al. (1980) reported that buffalo milk, boiled and subsequently coagulated at 70°C with citric acid at pH 5.7 employing delayed straining after standing at room temperature for 30 min, yielded chhana having soft and smooth body suitable for rasogolla preparation. While, Rajorhia (1987) advocated that buffalo milk chhana might be improved to significant extent by modifying certain processes. These include adjustment of fat content in milk to about 4.0 to 4.5%, homogenization at 140 kg/cm², addition of 0.05% sodium citrate prior to boiling, dilution with 25.0% potable water and coagulation with 1% citric lactic acid solution. The yield and quality of chhana depends on the type of milk, heat treatment prior to acidification, coagulation temperature, acidity of milk and acid mixture and the residence time of coagulum before separation (Jonkman & Das, 1993; Singh, 1994; Chaudhary et al., 1998).

2.2.1 Factors Controlling the Quality of Chhana

2.2.1.1 Type of milk

Cow milk is usually preferred for chhana preparation because it produces good quality rasogolla, which is soft, smooth and spongy (Ray & De, 1953; Date et al., 1958; Jagtiani et al., 1960; Mitra et al., 1967). Murthy & Rao (1982) claimed that it is possible to make satisfactory rasogolla form milk chhana by using lactic acid as coagulant. Mondal (1977) claimed to prepare...
acceptable quality of rasogolla form filled milk chhana. While, Rukhana et al., (2004) reported that rasogolla of good texture, taste and sponginess was prepared from cow milk added with 30% soya milk.

Buffalo milk as such leads to the production of very hard, brittle, chewy and coarse rasogolla (Date et al., 1958; Jagtiani et al., 1960; Kanawajia; 1975; Soni et al., 1980; Ahmed et al., 1981). Bhargava et al., (1988) reported that utilization of buffalo buttermilk solids in cow milk rasogolla, but springiness of buffalo buttermilk rasogolla was not significantly different form cow milk rasogolla. Buffalo buttermilk after 20% enrichment with milk gave rasogolla of high acceptability. With 40% incorporation of milk, the acceptability was even higher than that of cow milk rasogolla in such a way, buttermilk solids presently being wasted can be put to a profitable use. So, it is clear that addition of buttermilk in buffalo milk play a vital role in improving the quality of chhana suitable for rasogolla making.

2.2.1.2 Chemical modification of milk prior to chhana making

2.2.1.2.1 Addition of salts

Several workers have shown that calcium content has a direct correlation with the hardness of chhana. Date et al. (1958) treated buffalo milk either with a mixture of NaH$_2$PO$_4$ and Na$_2$HPO$_4$ (9g + 7g) or 0.1 to 0.2% sodium preparation resulted soft chhana, which produced soft quality rasogolla. Jagtiani et al. (1960) made rasogolla by adding calcium to cow milk to increase its calcium load, which resulted harder rasogolla. They showed that buffalo milk with part of its calcium removal by citric acid treatment produced fairly satisfactory chhana as well as rasogolla. Baisya & Bose (1974) observed that the addition of calcium and magnesium chloride to milk produced soft chhana, whereas sodium chloride, sodium acetate and sodium citrate did not affect the body & texture of chhana significantly. On the contrary, Jagtiani et al. (1960) observed that calcium in chhana was less when 0.25-0.30% sodium citrate added prior to boiling, dilution with 25% water and coagulation with 2% citric acid improved the quality of chhana to a
considerable extent. While, Choyde et al. (2003) reported that acceptable quality rasogolla was prepared from standardized (4% fat) buffalo milk chhana with 0.15% sodium citrate.

2.2.1.2.2 Addition of humectants

Sood et al. (2003) produced good quality rasogolla, 5% sorbitol treated buffalo milk providing all the sensory attributes at par with the product prepared from cow’s milk.

2.2.1.2.3 Ion Exchange of milk

Jagtiani et al. (1960) applied ion exchange technique to reduce the calcium load of buffalo milk but the chhana as well as rasogolla produced were not satisfactory.

2.2.1.2.4 Homogenization of milk

Kundu & De (1972) and Kanawajia (1975) obtained soft chhana by homogenization of buffalo milk. While, Iyer (1978) did not find any beneficial effect of homogenization of buffalo milk prior to chhana preparation.

2.2.1.3 Condition of coagulation

This involves the factors like type of coagulant, pH of coagulation and temperature of coagulation.

2.2.1.3.1 Type of coagulant

Generally, organic acids like citric or lactic acid or their salts (calcium lactate), lemon juice and whey are employed as coagulant. De & Ray (1954) reported that lactic acid tends to produce chhana with granular texture (fit for rasogolla preparation) while citric acid results in pasty texture (suitable for sandesh preparation). However, Rao (1971) and Singh & Ray (1977a) found that satisfactory quality of rasogolla could be made from citric acid coagulation. Gera (1978) suggested the use of sour whey for the production of soft quality chhana suitable for rasogolla preparation. Calcium lactate suitable for sandesh making (Sen & De, 1984). Pandey et al. (2004) prepared chhana from cow milk coagulated by lactic acid, citric acid, papaya extract...
and ginger extract and found that the average yields of chhana were 18.98, 18.70, 20.42, 21.12% with moisture contents of 52.47, 53.0, 60.07 and 59.63%, respectively.

Samanta et al. (2004) reported that canned rasogolla prepared form cow milk chhana coagulated by non conventional coagulant such as magnesium sulphate (5%) yielded maximum compared with other coagulants such as calcium lactate (5%), calcium chloride (10%), hydrogen chloride and sodium citrate.

2.2.1.3.2 Strength of coagulant

Low acid strength results in very soft body and smooth texture in cow milk chhana suitable for rasogolla preparation, but unsuitable for sandesh making (De & Ray, 1954). While, high acid strength (3%) had the reverse effect. the optimum strength of the coagulant solution should be between 1 to 2% citric or lactic acid to produce good quality of chhana made from both cow and buffalo milk fit for both the products (De & Ray, 1954; Iyer, 1978). Some workers recommended that good quality chhana could be prepared from 1% citric acid (Kundu & De, 1972; Ahmed et al., 1981; Verma, 1989; Adhikari et al., 1992). While, satisfactory quality of cow milk chhana can also be prepared from 0.5% of lactic acid coagulant (Soni et al., 1980) and 0.8% citric acid (Bhattacharya & Des Raj, 1980). Sour whey of 0.9% LA was found useful for chhana making by Mahanta (1964). Singh & Ray (1977b) also obtained good quality chhana from sour whey containing 1.6% LA.

2.2.1.3.3 pH of coagulant

The pH of milk coagulation principally regulates the moisture content and thereby the body & texture of channa. De & Ray (1954) and Kundu & De (1972) reported that good quality rasogolla could be obtained from chhana by coagulation of cow milk with citric acid at pH 5.4 to 5.5 and for buffalo milk at pH 5.7 at 70°C. Bhattacharya & Des Raj (1980) recommended citric acid as coagulant with the strength of 0.5%, 1.5% and 0.8%, respectively at pH level of 5.2, 5.4 and 5.6 for the preparation of rasogolla from cow milk. While,
reported that good quality rasogolla could be obtained from cow milk chhana made from pH of coagulation at 5.5 by 1% citric acid and for buffalo milk at pH 5.6. But, Verma (1989) reported that good quality of rasogolla was made from buffalo milk at 5.1 pH of coagulation.

2.2.1.3.4 Temperature of coagulation

The temperature of coagulation varied widely in production of channa. Singh & Ray (1977a) noted that coagulation temperature between 99°C and 100°C was useful for rasogolla preparation form cow milk. But, coagulation temperature of cow milk at 80°C was found to be optimum for rasogolla making (De & Ray, 1954; Bhattacharya & Des Raj; 1980) while, Adhikari et al. (1992) suggested 65°C.

2.2.1.4 Processing of chhana

2.2.1.4.1 Straining & washing of chhana

Immediate straining method of chhana was advocated for making rasogolla from cow milk (Singh & Ray, 1977a; Bhattacharya & Des Raj, 1980). Whereas delayed straining process was recommended for cow as well as for buffalo milk (Kundu & De, 1972; Iyer, 1978; Soni et al., 1980; Chandan, 1992). The main purpose of delayed straining is to improve the softness and smoothness of chhana, which is essential for making good quality of cham-cham. Delayed straining of chhana caused higher retention of moisture and better recovery of milk solids, which resulted in higher yield. Furthermore, dipping and washing of chhana into running water after straining, which is generally followed by the reputed sweetmeat makers, must have some influence on the products quality (Iyer, 1978; Soni et al., 1980; Bhattacharya & Des Raj, 1980; Adhikari et al., 1992).

2.2.1.4.2 Kneading of chhana

Most of the workers have shown that kneading of chhana is an essential step in rasogolla making which profoundly affects the textural properties of rasogolla. However, in all the studies, the workers used the
manual kneading process, which had neither scientific measurements nor their specifications to obtain a desirable quality consistency after kneading. Tarafdar et al. (1988) designed a disc grinder for mechanical kneading of chhana. They suggested a consistency coefficient (K) of 365 pa.s and time (Tc) of 24.8 sec of chhana was essential to obtain good quality of rasogolla in comparison to the product obtained from manually kneaded chhana.

### 2.2.2 Chemical Composition of Chhana

Wide variation in chemical composition of chhana has been reported in literature. Total solids, fat, protein, lactose and ash contents of cow milk chhana were reported in the range of 35.39-46%, 18.73-24.83%, 12.18-30%, 1.94-2.30% and 1.5-2.6% respectively. While, the same for buffalo milk chhana were 41.03-48.40%, 23.21-29.63%, 12.50-18.30%, 0.94-2.57% and 1.90-2.03%, respectively (De & Ray, 1954; Bhogra, 1988). Bhogra, (1988) reported Ca, P, Mg, Cu and Fe as 475, 250, 26, 0.13 and 0.36 mg per 100gm of cow milk chhana and 635, 347, 32.2, 0.14 and 0.53 mg per 100 gm of buffalo milk channa respectively. While, Adhikari et al. (1992) reported 220 mg and 420 mg Ca per 100 gm of chhana respectively made from cow and buffalo milk (Adhikari et al., 1993).

### 2.2.3 Textural Properties of Chhana

Texture of chhana is very important with regard to its application in the preparation of various sweets, which is influenced by several factors such as: the type of milk used and its fat percentage; pH and temperature of coagulation; method of straining and moisture content in chhana. Chhana of fine texture with velvety body is considered desirable (Ray & De, 1953). A compact close-knit smooth texture (Rangappa & Achaya, 1974), and a soft body are believed to ensure manufacture of good quality rasogolla, but a slightly less soft body together with smooth texture is desirable for making good quality sandesh (Ray & De, 1953).

Different workers Instron machine for measuring textural attributes of chhana (Verma, 1989; Desai et al., 1991; Adhikari et al., 1992; Sindhu &
Patil, 2004) under different conditions. Desai et al. (1991) and Sindhu & Patil (2004) used sample size of 1.9 cm diameter (2.84 cm²) and 2.0 cm height whereas Adhikari et al. (1992) used sample size of 1.9 cm diameter and 1.5 cm height. However, Verma (1989) used sample area of 1.313 mm² and 1.5 cm height. Adhikari et al. (1992) and Sindhu & Patil (2004) compressed the chhana sample 36.75% after tempering it for 4 hrs at 20°C and 15°C, respectively and Desai et al. (1991) compressed the chhana sample 20% after tempering it for overnight at 20°C, while Verma (1989) compressed the chhana sample 80% at 25°C.

In general, texture of chhana of varying quality has been described using arbitrary terms such as moist, creamy, greasy for visual attributes; soggy, velvety, hard and smooth for body and fine, coarse and granular for texture (Ray & De, 1953; De & Ray, 1954; Kundu & De, 1972; Rangappa & Achaya, 1974; Singh & Ray, 1977a; Iyer, 1978; Gera, 1978; Soni et al., 1980; Bhattacharya & Des Raj, 1980).

Gera (1978) studied rheological properties of cow, buffalo and skim-milk chhana by adopting physical tests namely pitching number, penetration value, viscosity, density and springiness. He observed that type of coagulants caused minor variation in the compactness of chhana, but lower pH (4.6) of coagulation increased the hardness and viscosity of chhana. Maximum springiness was observed at pH 5.7 for mixed and buffalo milk chhana, and at pH 5.1 for cow milk chhana. Density of chhana was higher at pH 4.6. Temperature of coagulation affected the softness and springiness of chhana. Higher viscosity of chhana remained unaffected. Buffalo milk chhana was springy followed by mixed milk (1:1) and cow milk chhana. Adhikari et al. (1992) reported 8.78 mN hardness, 0.58 cohesiveness, 3.60 mm springiness, 5.02 mN gumminess and 18.33 mN. mm chewiness in cow milk chhana. Adhikai et al. (1993) reported 18.40 mN hardness, or cohesiveness, 3.80 mm springiness, 11.40 mN gumminess and 41.95 mN .mm cohesiveness in buffalo milk chhana. Sindhu & Patil (2004) reported the effect of alteration of salt balance of cow milk by addition of sodium dihydrogen phosphate on Instron textural parameters of chhana. He found that increasing the level of
sodium dihydrogen phosphate in cow milk form 0.00% to 0.15% significantly reduced hardness, gumminess and chewiness of resultant chhana by 26.62, 23.82 and 26.91%, respectively. However, addition of sodium dihydrogen phosphate had no significant effect on cohesiveness, adhesiveness and springiness. The chhana prepared from cow milk added with 0.15% sodium dihydrogen phosphate had soft texture, comparable to market chhana with 3.96 mN hardness, 3.07 mN gumminess and 24.28 mN.mm chewiness. The corresponding values of cow milk chhana prepared by different methods have been reported to range from 5.59-22.26 mN, 3.74-16.19 mN and 24.85-166.19 mN.mm, respectively by Desai et al. (1991).

Several attempts have been made to improve the texture of buffalo milk chhana for production of soft quality rasogolla (Date et al, 1958; Kundu & De, 1972; Soni et al., 1980) Date et al. (1958) obtained soft chhana by treating a mixture of Na$_2$HPO$_4$ to NaH$_2$PO$_4$ to buffalo milk on addition of sodium citrate to buffalo milk before coagulation having lower firmness and chewiness and better smoothness. They noted that hard texture of buffalo milk chhana was due to its higher calcium content. Jagtiani et al. (1960) added 0.2-0.3% sodium citrate as softening agent before the coagulation of buffalo milk. They demonstrated that as the amount of calcium increased in cow milk, the resulting rasogolla was harder. Rao et al. (1989) also reported that chhana obtained from buffalo milk diluted with 20% water, added with 0.3% sodium citrate were almost identical chhana obtained from cow milk. Baisya & Bose (1974) observed that the addition of calcium citrate and sodium acetate did not affect the body & texture of chhana significantly. Soni et al. (1980) recommended coagulation of buffalo milk at 70°C with lactic acid at pH 5.7 employing delayed straining for 30 min yielded chhana having soft and smooth body suitable for the manufacture of rasogolla. Kumar (1982a) reported that desirable quality of chhana could be produced from buffalo milk by adopting conditions of coagulation and method of delayed straining as suggested by Kindu & De (1972) but excluding the homogenization step. Desai (1988) observed that buffalo milk chhana was more elastic, firm, crumbly and chewy and less sticky and less smooth as compare to cow milk and market made chhana whereas mixed milk (3:1) crumbliness and
chewiness and higher smoothness. Adhikari et al. (1993) reported 18.40 mN hardness, 0.60 cohesiveness, 3.80 mm springiness, 11.40 mN gumminess and 41.95 mN mm chewiness in buffalo milk chhana.

2.2.4 Storage Quality of chhana

De (1980) and Kumar & Srinivasan (1982c) observed that chhana could be kept good for only 6 days at 10°C and 3 days at 37°C, although, chhana started losing freshness on the third day of storage at 10°C.

2.2.5 Microbiological Quality of Chhana

Very few reports on microbiological quality of chhana are available. The market samples of chhana analyzed at National Dairy Research Institute, Bangalore were heavily contaminated with a variety of organisms. The average initial number of viable organisms per g of chhana was about 16.0 \times 10^3, which increased to 11.0 \times 10^7 in 48 hrs (Anon, 1955). The initial mould counts were 260 per g rising to 3.85 \times 10^8 at the end of 48 hrs. The most common types of moulds contamination in chhana samples belong to the genera Penicillium, Aspergillus, Mucor, Rhizopus, Fusarium and Paecilomyces. Singh & Mukhopadaya (1975) showed wide variation in total plate counts (0 - 9 \times 10^6), coliforms (0 - 139 \times 10^5), staphylococci (0 - 22 \times 10^4), and yeast and mould counts (0 - 77 \times 10^4), count per g of chhana collected from Kalyani and its suburbs. Kumar & Srinivasan (1982b) analyzed chhana samples prepared from cow milk, buffalo milk and collected from the market. The market samples carried higher count compared with laboratory samples. Cow milk chhana showed high counts except for lipolytic organisms and yeast and mould; high bacterial counts on chhana were favoured by high moisture content and unhygienic method of production.

2.3 PRODUCTION OF CHAM-CHAM

The method of preparation of all types of cham-cham from chhana is same as that as that of rasogolla (Bandyopadhyay et al., 2006). Whereas the technique of rasogolla preparation varies widely and has been proposed by different workers. The same technique would apply for preparation of cham-cham.
2.3.1 Cham-cham from Cow milk

Date et al. (1958) briefly outlined the method of rasogolla preparation adopted by the traders. Cow milk is coagulated by adding sour whey from previous batch of chhana made. The coagulum is filtered through cloth and whey is drained.

The chhana, thus obtained, used for cham-cham making, is kneaded for preparation of cylindrical balls and cooked into sugar syrup (58° brix) for ten minutes at 95°C with occasional stirring. Cooked chhana balls are transferred into soaking syrup (36.2° brix) at 50-60°C for one hour. Syrup is squeezed out from cham-cham as far as possible and placed in stainless steel trays (Bandyopadhyay et al., 2006).

2.3.2 Cham-cham from Buffalo milk

High calcium content, different protein make-up, higher total solids and curd tension of buffalo milk as compared with cow milk results in harder chhana (Jagtiani et al, 1960, De, 1976, Verma, 1989). Nothing has been reported with respect to preparation of cham-cham from buffalo milk.

2.3.3 Varieties of cham-cham

Various types of cham-cham are sold in the market viz., malai cham-cham, kashar cham-cham, carrat cham-cham and herbal cham-cham. Each of this type differs from the other with respect to taste, method of preparation and packing (Bandyopadhyay et al. 2006).

2.3.4 Factors controlling the quality of cham-cham

2.3.4.1 Moisture content in chhana

Bandyopadhyay et al. (2006) reported that a moisture content of 50-60% (preferably 55%) in chhana is used for good quality of cham-cham preparation. On the contrary report that not only the moisture but also the fat content influences the texture of cham-cham.
2.3.4.2 Fat content in chhana

Chhana obtained from cow milk having higher fat content give better recovery (Kundu & De, 1972; Bhattacharya & Desraj, 1980; Tambat et al., 1992; Ten Hove & Das, 1995). The high recovery be due to a higher number of fat globules in the milk, which associate with large amount of milk protein in the fat globules membrane (Walstra & Jenness, 1984). De (1980) recommended that a minimum fat content of 4% in cow milk and 5% in buffalo milk is essential to obtain chhana with satisfactory body and texture.

2.3.4.3 Strength of the cooking syrup

The strength of the sugar syrup plays an important role in controlling the body and texture of chhana, because in the cooking process if the concentration of the sugar syrup is not appropriate, balls may cracks, flatten or burst in extreme cases and thereby, loose the desirable characteristics of the furnished product. In the preparation of cham-cham, the strength of the cooking syrup varied widely (30-80%) from laboratory to laboratory. However, the strength of sugar syrup during cooking should be maintained 50% as boiling solution (Aneja et al., 2002). Bandyopadhyay et al. (2006) reported that strength of sugar syrup during cooking of cham-cham balls maintained 58° brix at 95° between 50 to 60%. However commercial strength of sugar solution is maintained at 55-60° brix.

2.3.4.4 Evaporation of water during cooking

Srinivason and Anantakrishnan (1964) suggested that during cooking of rasogolla balls, the syrup should not be allowed to concentrate in order to maintain the proper body and texture of the product. Consequently, frequent sprinkling of water during the process of cooking has been suggested (De, 1976, Soni et al., 1980)

2.3.4.5 Duration and temperature of cooking

Cooking of chhana balls in sugar syrup is an important step, leading to volume expansion, temperature rise, weight increase and change in mouthfeel quality of cham-cham. It is the process of cooking during which the
soft and smooth body of chhana balls changes to a fluffy and fibrous network, which provides spongy texture. Cooking under controlled temperature and specific time is very essential for getting quality products. Cooking time for cham-cham preparation is 10 minutes with occasional stirring made from cow milk (Bandyopadhyay et al., 2006).

2.3.4.6 Strength of final sugar syrup for soaking of cham-cham

This plays an important role in controlling the size, shape, body and texture of cham-cham. There is wide variation in strength of soaking sugar syrup (30-80%). The strength of soaking syrup should be maintained within 36.2° brix at 50-60°C with equilibrium time in one hour (Bandyopadhy et al., 2006).

The total solids, fat, protein, sucrose and ash contents of cow milk rasogolla were reported as 50.12-54.40%, 7.10-7.30%, 6.20-8.66%, 30.54-39.60% and 1.03-1.35%, respectively. Whereas Bandyopadhyay et al. (2006) reported total solids 80.78-85.56%, fat 9.23-13.56%, protein 8.03-1056%, lactose 1.2-3.09%, sucrose 57-45-61.89%, Ash 5.95-7.63%, Acidity 0.37-1.45% in malai chamcham where as total solids 79.38-83.92%, fat 9.67-15.03%, protein 8.17-9.54%, lactose 1.61-3.73%, sucrose 58.41-63.42% Ash 5.45-7.61% and Acidity 0.52-1.63% in kesar cham-cham.

Table 2.1 Chemical composition of cham-cham in percentage

<table>
<thead>
<tr>
<th>Type</th>
<th>Total solids</th>
<th>fat</th>
<th>Protein</th>
<th>Lactose</th>
<th>Sucrose</th>
<th>Ash</th>
<th>Acidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malai cham-cham</td>
<td>80.78-85.56</td>
<td>9.23-13.56</td>
<td>8.03-10.56</td>
<td>1.2-3.09</td>
<td>54.45-61.89</td>
<td>5.95-7.63</td>
<td>0.39-1.45</td>
</tr>
<tr>
<td>kesar cham-cham</td>
<td>79.38-83.92</td>
<td>9.67-15.63</td>
<td>8.17-9.54</td>
<td>1.61-3.73</td>
<td>58.41-63.42</td>
<td>5.45-7.61</td>
<td>0.52-1.63</td>
</tr>
<tr>
<td>Carrot cham-cham</td>
<td>75.51-77.13</td>
<td>6.45-13.05</td>
<td>4.95-7.32</td>
<td>-</td>
<td>59.43-61.02</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
2.3.5 Shelf life of cham-cham

Bandyopadhyay et al. (2006) reported that shelf life of chamcham made in Kolkata market depend the quality of chamcham. Shelf life of malai chamcham is 7-10 hrs whereas that of kesar chamcham, carrot chamcham and herbal chamcham are 6-12 hrs, 7-16 hrs and 10-15 hrs, respectively, at ambient condition.

2.3.6 Price of cham-cham

Bandyopadhyay et al. (2006) surveyed the Kolkata market for pricing. They found that local halwais sell the chamcham per piece and also calculated the cost of chamcham per piece in production. They reported that the cost of production of malai chamcham per pieces is Rs. 3-3.5, whereas that of kesar chamcham, carrot chamcham and herbal chamcham are Rs.3.5-40, Rs.2.75-3.0, Rs.4.0-4.5, respectively, and sold in Kolkata market at Rs.5, Rs.6, Rs.5 and Rs.7/- per piece, respectively. So, net profits perplexed of different varieties of chamcham are Rs.1.5-2.0, Rs.2-2.5, Rs.2.20-2.50 and Rs.2.5-3.00, respectively.