Review of Literature

The literature pertaining to different aspects of the present study has been reviewed under the following captions.

2.1 Chemical composition of milk
2.2 Coagulants used in preparation of paneer.
2.3 Technology of preparation of paneer
2.4 Chemical composition of paneer
2.5 Sensory qualities of paneer
2.6 Textural properties of paneer
2.7 Storage study of paneer
2.8 Cost of production of paneer

2.1 Chemical composition of milk

Saini and Gill (1991) cited composition of goat milk as fat 3.8 per cent, solids-not fat 8.68 per cent, lactose 4.08 per cent, total protein 2.9 per cent, casein 2.47 per cent, albumin and globulin 0.43 per cent, total ash 0.79 per cent per cent. Similarly, lower fatty acids on per cent weight in goat milk were caproic 2, capric 10, caprylic 3 per cent.

Winton and Winton (2000) conclusively remarked that goat milk was superior to cow and buffalo milk and even human milk because it is reasonably rich in sodium, calcium, magnesium,
iron, copper and phosphorus. Human milk was poor in phosphorus and calcium, cow milk in iron and copper and buffalo milk in iron and copper.

Haenlein (2001) reported chemical composition of goat milk as compared with various species

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Goat milk</th>
<th>Cow milk</th>
<th>Buffalo milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>87.5</td>
<td>87.7</td>
<td>86.7</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>4.1</td>
<td>3.7</td>
<td>7.5</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>4.7</td>
<td>4.4</td>
<td>4.7</td>
</tr>
<tr>
<td>Total solid (%)</td>
<td>12.5</td>
<td>12.3</td>
<td>13.3</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.82</td>
<td>0.72</td>
<td>0.90</td>
</tr>
</tbody>
</table>

2.2 Coagulants used in preparation of paneer.

Agnihotri and Pal (1996) reported that citric acid is the most commonly used coagulant for paneer manufacture. But due to its high cost, feasibility of using goat milk paneer whey, a by-product of paneer manufacture, as a coagulant can be explored.

Masud et al (2007) studied the effect of coagulation temperatures and strength of coagulant on the quality and quantity of paneer prepared from buffalo milk. Paneer prepared at 95oC required minimum amount of coagulant, contributing low cost of production.

Karadbhajne et al. (2010) standardized buffalo milk on the level of fat (6 percent milk fat, 9 percent SNF) and manufactured paneer using different coagulants, and studied organolactic
test, chemical analysis and texture profile for hardness, firmness and springiness of freshly paneer during 8 days storage at 4-60°C. In case of ascorbic acid, the paneer prepared from 2% and 4% ascorbic acid was found very good in terms of %yield, colour, flavor, taste, and even in terms of shelf life as compared to citric acid, lactic acid and tartaric acid. Similarly texture profile analysis shows that firmness and springiness of 2% ascorbic acid was more compatible for 8 days as compared to other coagulant used.

2.3 Technology of preparation of paneer

Bhattacharya et al. (1971) standardized procedure for paneer making from buffalo milk. Buffalo milk was standardized to 6 per cent fat and heated to 82°C for 5 minutes in jacketed vat. Coagulation was brought about at 70°C by slowly adding 1 per cent citric acid solution with constant stirring till a clean whey separated out and the coagulation was allowed to settle for 5 minutes and whey was drained off. During this procedure, temperature was not allowed to fall below 65°C. The curd was filled in a hoop lined with cloth. Pressure was then applied on the top of the hoop by applying a weight of 4.5 kg/cm² for about 15 minute. The present block of paneer was removed from the hoop and after 6-8” pieces was immersed in chilled water for 2 to 3 hours. The chilled paneer was then removed from water. Finally paneer blocks were wrapped in parchment paper and stored in a cold room (temperature 10°C) until marketing.

Singh and Kanawjia (1991) studied the quality of paneer made from recombined milk at different coagulation temperature using calcium chloride prior to coagulation. They observed that paneer obtained from recombined milk coagulated at 90°C with addition of 0.15 per cent calcium chloride recorded highest yield and total solids recovery but had low score for all the sensory attributes as compared to control paneer. They further reported that with increase in coagulation temperature to 95°C with addition of 2 per cent calcium chloride resulted in slightly hard chalky paneer with lower solids recovery.

Arora et al. (1996) studied the quality of paneer made from substandard buffalo milk diluted with water so as to lower down the fat and SNF to 4.6 and 8.0 per cent, respectively. The calcium chloride was added to diluted milk in different concentrations. They observed that acceptable quality paneer could be made from adulterated buffalo milk with addition of 0.05
per cent calcium chloride by using the same technology being used for the manufacture of paneer from buffalo milk.

Nayak and Bector (2001) observed that paneer prepared from milk added with urea was prepared from buffalo milk and skim milk standardized to fat SNF ratio of 1:1.65 and divided into three equal parts, the two parts treated with solution of urea at 0.05 and 0.1 per cent of milk respectively and remaining part was used as control without urea addition.

Bhadkekar et al. (2008) prepared the paneer from buffalo milk blended with sago powder. Buffalo milk was standardized to 6 per cent fat and 9 per cent SNF standardized milk was heat at 82°C for 5 minutes and then mixed the sago powder level @ 0.3, 0.4 and 0.5 per cent. Milk was cooled at 70°C then coagulant was added 1 per cent citric acid solution. After complete coagulation, the whey was completely drained off through stainless steel strainer. The curd was collected and filled in wooden blocks lined with muslin cloth. Pressure was applied on the top at the rate of 3.5 kg/cm² for 15-20 minute. The pressed blocks were immersed in chilled water for 2 to 3 hours. The chilled paneer was removed from water and allowed to drain out water and packed in polythene bag and finally stored in refrigerator.

2.4 Chemical composition of paneer

Arora and Mital (1991) reported that addition of skim milk to soy milk decreased the yield but there was increase in total solids, protein content and shear strength of soy paneer. Paneer prepared from soy milk alone contained (in per cent): moisture 74.85 per cent, protein 16.63, fat 4.26, ash 0.37 and carbohydrates (by difference) 3.89. Paneer prepared from soy milk - skim milk blend (80:20), moisture 69.46 per cent, protein 20.98 per cent, fat 3.77 per cent, ash 0.78 per cent and carbohydrates (by difference) 5.01 per cent. Use of soymilk - skim milk (80.20) blend yielded a product to regular paneer in total solids.

Singh and Kanawjia (1992) studied the effect of TS levels in milk on yield and composition of paneer that the yield of paneer increased with increased TS levels in milk. The increased yield ranged from
22.10 to 34.00 per cent. The maximum yield obtained from 25 per cent TS milk. The fat and protein contents in milk powder paneer (MPP) ranged from 17.40 to 19.12 per cent and 21.94 to 22.80 per cent, respectively. The TS recovery in MPP ranged from 62.92 to 60.65 per cent which is maximum in case of paneer made from 15 per cent TS milk and the minimum from 25 per cent TS milk. Up to 18 per cent TS milk could be used for manufacture of paneer without losing many solids in whey.

Bajwa et al. (2005) studied changes occurred during storage of vegetable impregnated paneer in which they prepared plain paneer, mint impregnated paneer and coriander impregnated paneer and reported that moisture content was 55.20, 56.29 and 57.14, respectively protein was 40.19, 39.30 and 38.85, respectively fat 52.88, 51.11, and 51.83 respectively.

Kumar et al. (2008) studied the effect of different levels of lactic acid on the chemical attributes of the paneer. Study was conducted to determine the influence of different amount of lactic acid viz. 0.2, 0.4, and 0.6 per cent on the paneer. They reported that the incorporation of lactic acid at the rate of 0.2 per cent brought about a significant \((P<0.05)\) improvement in yield, moisture, protein content and total solid recovery as compared to the product prepared with 0.6 per cent coagulant.

Singh et al. (2010) studied the selection of optimum substitution level of cow milk with soy solids to manufacture low fat paneer. They indicated that by increasing level of soy milk in blends both fresh yield and fat content in paneer decreased significantly \((P<0.05)\) than 3.5 per cent cow milk paneer. While the incorporation of soy solid in milk: soy milk blends increased moisture retention and protein content in resulting paneer, the total carbohydrate and ash content was almost similar in soy solid based paneer samples obtained from all the treatments. By and large results indicated that substitution of 3.5 per cent cow milk with soy milk up to 30 per cent was found most suitable to produce paneer of acceptable quality.

Pal et al. (2011) prepared paneer from fresh goat milk and reported that the yield recovery 13.31-19.34 per cent, moisture 42.22-51.80 per cent, protein 17.86-21.88 per cent, fat 24.50-29.50 per cent and ash content 1.53-2.23 per cent.
Khan et al. (2012) optimized the process for paneer production from milk powder and reported that the effect of reconstitution levels on chemical quality of paneer. 1:6 level of milk powder: water (reconstitution level) had highest protein, total solids and yield 18.11, 58.85 and 131g respectively.

2.5 Sensory qualities of paneer

Bhattacharya et al. (1971) prepared paneer from different levels of milk fat and found that sensory quality of paneer was very good from milk of more than 5.0 per cent fat and fair for paneer prepared from skim milk.

Pandit and Sen (1998) reported that soy paneer was prepared with different strengths of fumeric acid and sour whey. Amongst them 10 per cent fumeric acid solution gave the highest yield whereas 0.5 per cent sour whey gave the lowest yield however, 2.0 per cent fumeric acid solution produced soy paneer with firm body, smooth texture and desirable elasticity and produced the beany flavour, whereas, soy paneer prepared with 3.0 per cent fumeric acid solution resulted hard body and coarse texture.

Kanawjia and Rizvi (2003) prepared paneer from MF-Retentate, they reported that increase level of CaCl$_2$ from 0.05 to 0.15% increases the flavour, body and texture of the product but at level of 0.30 per cent CaCl$_2$ the scores for flavour, body and texture of the product decreases.

Bhadekar et al. (2008) used sago powder for preparation of paneer from buffalo milk and studied the sensory and overall acceptability of the final product and concluded that increase in the level of sago powder there was decrease the colour, appearance, flavour, body, texture, taste and overall acceptability of the final product. Buffalo milk with 0.3 per cent sago powder (99.6 per cent buffalo milk + 0.3 per cent sago powder) as a base material for paneer preparation is most acceptable.

Biradar et al. (2012) studied physico-chemical quality of paneer prepared from blends of soymilk and buffalo milk, they concluded that color, flavour, body, texture and overall acceptability of the product decreases with increase in the level of soymilk from 10, 20, 40 and 50 per cent.
2.6 Textural properties of paneer

Jadhav (1989) studied the textural qualities of paneer prepared from buffalo milk. The buffalo milk paneer was superior as it exhibited minimum values for hardness, gumminess, chewiness and maximum values for cohesiveness and springiness which due to higher fat content of it.

Desai et al. (1991) compared the textural attributes of raw paneer samples collected from six prominent shops of Karnal market, by using Instron Universal Testing Machine, Model 4301 fitted with a 100 N load cell. They observed that the hardness, gumminess and chewiness of raw paneer varied significantly (p < 0.01) among different suppliers, whereas the variations in the cohesiveness and springiness were not significant. They further observed that the lower values for hardness in some of the studied samples could be due to higher moisture content in those samples, while the greatest value for hardness in a particular paneer test sample might be due to highest calcium content in addition to low moisture content in it.

Syed et al. (1992) reported that in comparison to paneer prepared from cow buffalo milk, skim milk paneer showed higher values for hardness (3.00 kg), gumminess (0.86 kg) and chewiness (1.396 kg) and lower values for cohesiveness (0.27), and springiness (1.50 cm). According to them the maximum hardness in case of skim milk paneer might be due to low fat, high protein and ash content.

Alokpanet al. (1993) studied on Tofu and milk paneer by employing Instron 6021. Tofu exhibited significantly higher springiness than milk paneer. However, fried tofu exhibited significantly higher hardness, springiness and chewiness but significantly lower cohesiveness than fried milk paneer. The springiness of tofu and milk paneer remained more or less unaffected by frying, while the other characteristics increased significantly upon frying.

Kanawjia and Singh (1996) studied textural changes in paneer during storage. Paneer was manufactured from standardized buffalo milk treated and stored at 6 to 8°C or 28 to 30°C. The refrigerator samples were of acceptable quality up to 45 days. Flavour and texture of frozen paneer samples were acceptable after 60 and 30 days storage, respectively. The textural profile analysis
revealed that all textural properties of refrigerated paneer such as hardness, springiness, cohesiveness, gumminess and chewiness initially increased up to 15 days and thereafter appreciably decreased. Controversially all textural properties of frozen samples consistently deteriorated.

Mathare et al. (2009) observed the effects of coagulation temperature on the texture of soy paneer, they concluded that hardness, cohesiveness, chewiness and adhesiveness increases with coagulation temperature up to 90°C, and then decreases with the increase in the temperature.

Mudgal and Agrawala (2010) studied textural analysis of buffalo milk paneer using universal instron machine. They obtained the values of hardness, cohesiveness, adhesiveness, springiness, gumminess and chewiness as 29.52 N, 0.62, 11.9 N, 7.5 mm, 20.06 mN and 127.63 mN.Mm respectively.

2.7 Storage study of paneer

Bureau of Indian Standards (BIS) (IS: 10484, 1983) recommended the following microbiological standards for paneer.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Count/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total plate count</td>
<td>$&lt; 5 \times 10^3$</td>
</tr>
<tr>
<td>Yeast and mould</td>
<td>$&lt; 250$</td>
</tr>
<tr>
<td>Coliform count</td>
<td>$&lt; 90$</td>
</tr>
</tbody>
</table>

Sachdeva et al. (1991) reported that paneer packaged in laminated pouches had a shelf life of about 30 days at refrigerated storage (6 ± 1 °C).

Rao et al. (1992) utilized hurdle technology involving mild heat treatment, minor reduction in water activity and acidification (pH 5.0) to extend their shelf life of paneer to 14 days at 30 °C.

Pal et al. (1993) found that the SPC, yeast and mould and coliform count of paneer were 3.03, 1.90 and 0.86 log cfu/g respectively.
Punjrath et al. (1997) depicted that paneer packaged in high barrier film (EVA/EVA/PVDC/EVA) under vacuum and heat treated at 90 °C for one min was reported to have a shelf life of 90 days under refrigeration.

Das and Ghatak (1999) compared microbiological quality of paneer samples procured from greater Calcutta market with those of prepared in the laboratory, noted that the various microbiological counts were higher in case of market samples.

Singh and Rai (2004) used hot (60 °C for 5 min) and cold (8–10 °C for 6 h) diffusion of paneer cubes with sodium chloride and potassium sorbate and subsequent microwave drying to extend their shelf life.

Srivasatva (2004) reported that in freshly prepared paneer samples, the average SPC was log 3.462, which was much lower than the standards (<5x10^7) set by BIS. The average anaerobic microorganism count in fresh paneer was observed to be log 2.954. The coliform counts were found to average log 1.748 in fresh paneer samples, which was lower than the value (£ 90) specified by BIS. The yeast and moulds (Y and M) count averaged log 1.338, which is again less than the count (<250) given by BIS.

Nath et al. (2007) observed SPC of 5.4 x10^3 and yeast and mould count of 260/g in freshly prepared paneer.

2.8 **Cost of production of paneer**

Gadhave (2001) studied the cost of production of paneer prepared from safflower milk blended with buffalo milk were reported that as safflower milk level in the blend increased, the cost of production was decreased.

Patil (2003) prepared paneer from cow milk and coconut milk blend and concluded that increase in the coconut milk level in the blend there was decrease in the cost of production of paneer.

Bolange (2006) prepared paneer from buffalo milk blended with coconut milk and reported that the cost of paneer can be minimized by using standardized buffalo milk and coconut milk blend.