**Paper No.: 07**
**Paper Title: TECHNOLOGY OF MILK AND MILK PRODUCTS**
**Module – 19: Technology of Paneer**

Paneer, a popular indigenous dairy product of India, is an unripened variety of soft cheese and is used in the preparation of a variety of culinary dishes, snacks and sweetmeats. It is used in several vegetable dishes like matar paneer, palak paneer, etc. The ability of paneer to be deep fried is one feature that has led to its wider acceptance and a favourite for making snacks, pakoras and fried paneer chunks. Paneer is indigenous to South Asia and was first introduced in India by the Afghan and Iranian travelers. Paneer is obtained by the heat and acid coagulation of the casein component of milk, entrapping through complex physico-chemical interactions almost all other constituents.

India is considered as an agrarian country in which major proportion of population is vegetarian. Paneer is obtained by acid coagulation of heated milk with citric acid, lactic acid, tartaric acid, alum or sour whey, the resulting moisture being removed by filtration and pressing. Paneer represents one of the soft varieties of cheese family and is used in culinary dishes/snacks. Approximately 5 % of milk produced in India is converted into Paneer (Chandan 2007). The estimated market (traditional and organized sectors) for Paneer was 4,496 metric tones in 2004 (Joshi, 2007), with a growth rate of 13 % per annum.

***Characteristics of Paneer***

Typically, paneer is marble white in appearance, having a slightly spongy body and possessing a sweetish-acidic-nutty flavour, firm cohesive and compact body and a close knit-texture. The color of product should be pleasing white, with a greenish tinge when made from buffalo milk and light yellow when made from cow's milk.

***Legal requirements***

According to Food Safety and Standards Act (FSSA), Paneer (also for Chhana) means the product obtained from cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70% moisture and the milk fat on dry matter (FDM) should be minimum 50%. Milk solids may also be used in preparation of the

product. Bureau of Indian Standards (BIS) specified a maximum moisture content of 60 % and minimum FDM of 50 % (BIS, 1983).

***Nutritional quality of Paneer***

Paneer is of great value in diet, especially in the Indian vegetarian context, because it contains a fairly high level of fat and proteins as well as minerals, especially Ca and P. It is a good source of fat soluble vitamins like A and D. Paneer retains about 90 % fat and proteins, 50 % minerals and 10 % lactose of the original milk. The protein efficiency ratio (PER) and biological value (BV) of paneer prepared from buffalo milk, cow milk and mixed milk were 3.4 and 86.56, 2.3 and 81.88, and 2.3 and 80.38 respectively. The digestibility coefficient of paneer obtained from such milks was identical. Buffalo milk paneer has higher Net Protein Utilization (NPU of 83.10) as compared to cow milk paneer (78.28).

***New variants of paneer***

Examples of some new paneer entrants include skim milk paneer, low-fat paneer, reduced-fat paneer, fiber enriched low-fat paneer, low-fat paneer enriched with whey protein concentrate (WPC)/soy protein isolate (SPI), ultrafiltered paneer, vegetable impregnated paneer, paneer spread, paneer pickle, spiced paneer, masala paneer, fruit paneer, processed paneer, long-life paneer, filled paneer, etc. Soy paneer (i.e. Tofu) is a strong competitor of paneer, obtained from soymilk.

**Technology of Paneer**

Paneer making is simply coagulating the previously standardized and heat treated milk using suitable acids (including sour whey), draining the whey followed by pressing of the coagulated mass till a dense block is obtained which is subsequently chilled in chilled water and then diced, if needed before packaging the same. The pressed block of curd is removed, cut into pieces and immersed in chilled water of 5-6°C for about 2 hours. Dipping of paneer pieces facilitates cooling of product and improves the body and texture of paneer.

***Hooping and pressing:*** The coagulated mass is transferred to a hoop, lined with muslin cloth and the hoop subjected to pressing to obtain compact mass of paneer.

The process flow chart is depicted in Figure 1.

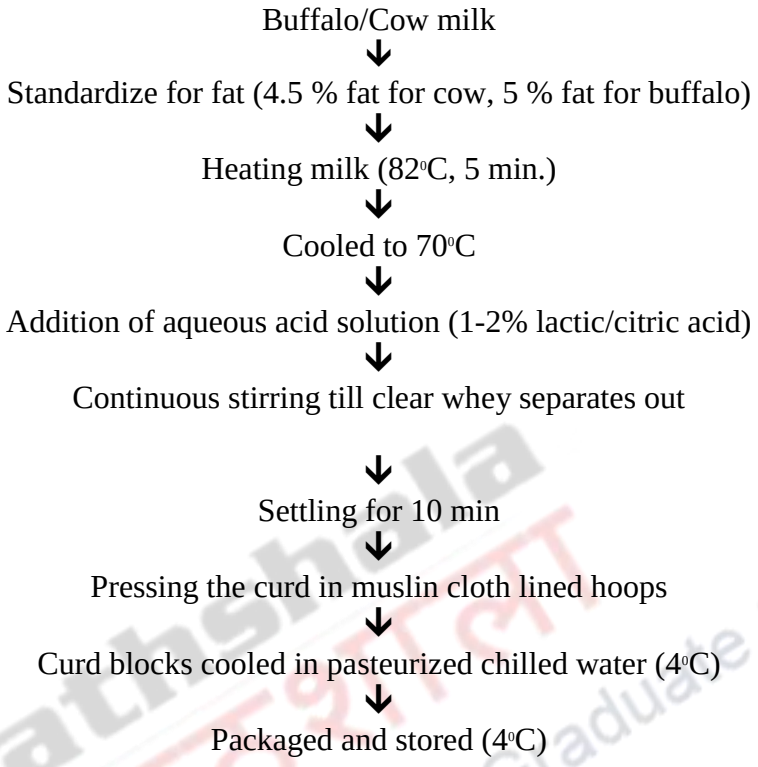


**Fig. 1 Flow chart for manufacture of Paneer**

***Industrial manufacture of Paneer***

An industrial scale paneer manufacturing facility based on the above methodology has been developed by the National Dairy Development Board (NDDB) having a capacity of 80 kg paneer/hr employing twin-flanged apron conveyor cum filtering system, which is being commercially used (Aneja, 1997). In this process, the milk is heated to 85°C and cooled to 75°C in a plate heat exchanger and pumped to a cheese vat for coagulation. Rest of the procedure is as followed in conventional method.

For mechanized pressing, paneer curd obtained through coagulation was kept in cages made from a special type of screen and the cages were subjected to impact forces. The impact type device compressed the blocks of chhana, which could be taken out at regular intervals (Das, IIT, Kharagpur).

***Composition of Paneer***

The composition of paneer obtained from cow milk, buffalo milk and mixed (cow+buffalo) is shown in Table 1.

**Table 1. Composition of Paneer obtained from cow and buffalo milks**

| Milk type | Constituents (%) | | | | | Reference |
|---|---|---|---|---|---|---|
| | Moisture | Fat | Protein | Lactose | Ash | |
| Buffalo (4% fat) | 54.05 | 23.27 | 16.78 | 2.69 | 2.20 | Chawla *et al.* (1987) |
| Cow milk (4.5% fat) | 55.26 | 24.15 | 18.43 | 2.01 | 1.45 | Syed *et al.* (1992) |
| Mixed milk (5% fat) | 49.00 | 26.10 | 20.80 | - | - | Desai (1988) |

**Factors affecting the quality of Paneer**

***Type of milk***

Cow milk paneer has a soft and spongy body and a relatively open texture whereas, buffalo milk paneer has firm and spongy body and a close texture. Normally, 4.5-5.0% fat in milk is required to make paneer complying with the FSSA standards. Buffalo milk is more suitable than cow milk for paneer making, especially for cooking purpose. Higher amount of casein and minerals (Ca, P) is responsible for imparting firm and rubbery body to buffalo milk paneer.

Buffalo milk having 5-6% fat is deemed to be most suitable (Bhattacharya *et al.*, 1971 and Sachdeva and Singh, 1988a) for paneer making.

Mixed cow and buffalo milk (1:1) standardized to 5 % fat yielded superior paneer than cow's milk paneer. Use of such blend, standardized to 3.5% fat is suited for production of low-fat paneer. One alternative method is to use blend of buffalo skim milk and whole cow's milk (80:20) for paneer making.

Goat's milk failed to produce a compact mass upon acidification. However, sheep milk paneer resembled buffalo paneer. Paneer making has also been standardized from ewe's milk with 6.94 % fat.

**Low-fat paneer**

Low-fat paneer with 42 % FDM (as against 50 % FDM for full fat product) could be made from cow/buffalo milk standardized to 3.5 % fat. Use of 0.1% sodium citrate or 0.5% NaCl to milk helped in increasing the moisture content of low-fat paneer leading to better body-texture and higher yield.

**Paneer from reconstituted dried milk**

Acceptable quality paneer could be made from reconstituted whole milk (from whole milk powder) having 15 % TS. Buffalo milk when fortified with skimmed milk powder (SMP) helped in improving the yield of paneer to 24.4% (vs. 18 % for control).

**Additives in paneer making**

***Calcium chloride:*** To produce good quality paneer from cow milk, it was necessary to add calcium chloride at levels of 0.08-0.15 % to milk prior to its coagulation; such treatment led to increased TS recovery and yield of product.

***Gums:*** Other than carboxy methyl cellulose (CMC @ 0.1-0.2%) use of other hydrocolloids (@ 0.1-0.15% of the hydrocolloids) viz.,, sodium alginate, iota-carrageenan, and pre-gelatinized potato starch enabled protein to be coagulated at 90$^{o}$C, which led to improved TS recovery and aided mechanization (since after pasteurization there was no need to cool the milk for coagulation). Use of CMC helped in reducing the oil uptake by panner during deep fat frying.

Use of Bendi gum at 0.45% level yielded paneer of desirable quality with higher yield (i.e. 15.23 vs. 12.87 % without gum) at low cost (6.34 % cost reduction). Use of 0.1% pre-gelatinized starch helped in improving the body-texture and yield of filled paneer.

**Milk pre-treatment**

***Homogenization:*** Homogenization of cow milk improved the yield and sensory quality of resultant paneer. However, homogenization of buffalo milk, or homogenized buffalo skim milk mixed with unhomogenized cream, did not improve the flavor of low-fat Paneer.

***Ultrafiltration:*** Use of UF retentate (i.e. concentrate having 27% TS) in paneer making resulted in improved sensory quality and increased yield by 25% through better retention of whey proteins in product.

**Type, strength and amount of coagulant used**

Various coagulants that have been used including sour whey, whey cultured with *L. acidophilus* citric acid, lactic acid and alum. Citric acid at 1-2 % concentration is the most widely used coagulant for paneer making. About 2.5 g of citric acid or lactic acid is required to coagulate 1 kg of milk; homogenized milk requires slightly higher quantity of coagulant. It was found necessary to use 1.41 and 1.52 g of citric acid per kg of buffalo milk and cow milk respectively for coagulation, while another report suggested use of 1.95 g citric acid (1%) for making paneer from 1 kg cow milk, regardless of its fat content (Pal and Yadav 1991; Chawla *et al.* 1987). The yield and moisture content of fresh paneer decreased, while fat losses in whey and acidity of paneer increased with increase in usage level of citric acid from 0.3 to 0.5 %.

Ascorbic acid at 2-4 % level as coagulant yielded paneer with superior yield (20.91 and 19.10% using 2 and 4% acid respectively), sensory quality, texture (firmness, springiness) and shelf life compared to use of citric, lactic and tartaric acids. Other acids like acetic acid imparted a vinegar flavour to paneer while tartaric acid was reported to be expensive.

**Factors affecting quality of paneer**

***Heat treatment of milk and coagulation temperature:*** Heat treatment of milk prior to acidification caused destruction of microorganisms, denaturation of whey proteins and reduction in colloidal calcium phosphate solubility. The recommended temperature-time combination for heating milk prior to coagulation of milk is: $80^0$C without holding to holding it for 10 min., $82^0$C for 5 min., $85^0$C without holding to holding for 5 min. and $90^0$C without holding. A coagulation temperature of $70^o$C has been recommended; temperatures greater than this resulted in hard and dry paneer, while lower temperature led to free moisture on the surface of paneer. The coagulation temperature influenced the moisture content of paneer; higher temperature led to lower moisture content and thus lower yield.

***pH of coagulation:*** The optimum pH of coagulation suggested by researchers is 5.3-5.35 for buffalo milk and 5.20-5.25 for cow milk paneer. The moisture retention in paneer decreased with a fall in pH, which led to decreased yield. With rise in pH of coagulation (i.e. from 5.1 to 5.4), there was an increase in moisture and thus yield of paneer.

***Yield of paneer***

Paneer having 51-54% moisture is expected to exhibit yield of 21-23% and 17-18% when made out of standardized buffalo and cow milk respectively. When coagulation temperature is raised, the yield of cow milk paneer is favoured while yield of buffalo milk paneer is reduced. Homogenization treatment is beneficial with regard to yield of resultant paneer; inclusion of hydrocolloids also has similar impact.

***Sensory quality of Paneer***

Addition of 0.08 % $CaCl_2$ to cow milk resulted in paneer having compact, sliceable, firm, cohesive body and a closely knit texture. A positive relation between fat content and the acceptability of paneer has been noted. As the temperature of heating of milk was raised from $85^0$C to $90^0$C, the flavor and body and texture of paneer was improved.

Best sensory score and yield of paneer was realized when adopting coagulation temperature of $70 \pm 2^o$C, pH of coagulation $4.85 \pm 0.23$ and stabilizer concentration of $2.91 \pm 0.11$ g/kg.

***Microbiological quality of Paneer***

The microbiological quality of paneer depends upon the post-manufacturing conditions, particularly, handling, packaging and storage of the product. Deterioration of paneer during storage is mainly due to the growth of spoilage organisms. Increase in total yeast and mould, and coliform count in stored paneer has been observed. Paneer having SPC of lower than 5000 cfu/g and lower than 10 cfu/g of coliform was considered 'Excellent' in terms of microbial quality (Vishweshwaraiah and Anantakrishnan, 1985). Fresh Paneer has been reported to have an initial count ranging from $2.3 \times 10^4$ to $9.0 \times 10^4$ cfu/g. The initial yeast and mould count ranged from $3.5 \times 10^2$ to $5.2 \times 10^2$ cfu/g. The coliforms and yeast and moulds were completely destroyed during heating of milk at $82^o$C/5 min., but these contaminants showed up due to post-manufacturing practices.

***Packaging and Shelf life of Paneer***

Paneer can be stored for only 6-15 days when stored at $10^0$C without much deterioration in its quality; the freshness of the product was lost in about 3 days. The flavour of paneer remained acceptable even after 120 days when stored at –13 or $-32^0$C, but the body and texture was adversely affected. Paneer packaged in laminated pouches had a shelf life of 30 days under

refrigeration (6$^{o}$C). Paneer packaged in high barrier film (EVA/EVA/PVDC/EVA) under vacuum and heat treated at 90$^{o}$C/1 min led to 90 days shelf life under refrigeration. [refrigearation.] Coating of paneer blocks with paraffin wax helped in improving the shelf life of paneer. Packaging of paneer containing preservatives, with or without vacuum, extended its shelf life to 50 and 35 days respectively at 8$^{0}$C. Vacuum packaging is highly advocated. The paneer packaged in vegetable parchment paper showed greater decrease in moisture during storage than that packaged in polyethylene; the increase in titratable acidity of paneer was greater in former package. Use of sodium nitrite as preservative added to milk in paneer making used @ 500-1000 ppm helped in enhancing the shelf life of product.

Dipping the paneer blocks (i.e. 1.5 kg) in 5 % chilled brine or acidified chilled water (pH 5.5) helped in enhancing the shelf life of product. Wrapping paneer in sorbic acid coated butterpaper enabled shelf life of 30 days at ambient temperature storage. Reduced fat (30-42% FDM) paneer had greater shelf life compared to full-fat paneer (> 50 % FDM). Blast freezing (-20$^{o}$C) of paneer blocks enhanced shelf life to 1 year when stored in deep freeze cabinet (-19$^{o}$C).

Modified Atmospheric Packaging (MAP) was carried out using a mixture of $CO_2$:$N_2$ (1:1), coupled with hurdle technology by use of NaCl (1-3%), citric acid (0.01-0.1%) and potassium sorbate (0.1 %). NaCl at 3 % reduced $a_w$ from 0.994 to 0.970 and citric acid at 0.1 % reduced pH from 5.6 to 5.1 in product. The treatment helped in enhancing the shelf-life from 1 to 12 days at room temperature (30$^{o}$C) and 6 to 20 days at refrigeration (7$^{o}$C) temperature.