

Physico- chemical changes in milk constituents during manufacture and storage of Khoa and Paneer

India is emerging as the highest milk producing country in World with an annual production of 140 million tonnes. A large quantity of milk produced in the country amounting to over 54% is being converted into various milk products; share of the traditional milk products comes to about 37%. The market value of traditional products is considered to about to be 578 billion. The consumption of traditional milk products is likely to grow at an annual growth rate of more than 20%.

Traditional dairy products play a significant role in the economic, social, religious and nutritional wellbeing of the Indian masses .It is still mostly prepared, packed and or marketed by old traditional method without mechanization or well documented standardization of the process under unsanitary condition and have a poor shelf life. However, these products offer several technological benefits, viz. their mass appeal, lower cost of production, simple manufacturing technique, adopted at rural level/ collection centre, high profit margin, generate lots of employment , value added products and nutritional status and have high export potential . The classification of these products based on the principle of their manufacture is given below.

Classification of Traditional Dairy Products

Type	Base Material	End Products
Acid coagulated	Chhana Paneer	rosogolla,sandash,pantaoa,cham- cham,chhana mukri,chhana- podo,sitabhog Culinary dishes
Heat desiccated	Khoa -	Peda,burfi,kalakand, milk cake ,gulabjamun,rabri

Fermented/cultured	- Chakka	Dahi.,misti doi,lassi Shrikhand,shrikhand wadi
Fat rich	Ghee	Fat rich
Frozen	-	Kulfi/malai
Cereal based	-	Kheer,payasam,firni

Paneer:

Paneer is an indigenous white (soft) cheese (unripened) which is used extensively as an ingredient in many vegetable delicacies. About 4 -5 % of the total milk produced in India is converted into paneer .Good quality paneer is obtained when standardised buffalo milk (fat:SNF, 1:1.65) heated to 90°C and coagulating the milk with 1% citric acid at 70°C and also characterized by a white colour, sweetish, mildly acidic, nutty flavour, spongy body and close knit texture.

Definition of Paneer:

According to Prevention of FSSA (2006), paneer is the product obtained from cow or buffalo milk or combination thereof by precipitation with sour milk, lactic acid or citric acid. Milk solids may be used in preparation of this product. It shall not contain more than 70% moisture and the milk fat content shall not be less than 50% of the dry matter. Paneer when sold as low fat chhana, it shall not more than 70% moisture and the milk fat content shall not more than 15% of dry matter.

Coagulants used: Lactic acid, Citric acid, Malic acid, Vinegar, Glucono delta lactone, Sour whey.

Chemical composition of paneer

Parameter (%)	Cow	Buffalo
Moisture	52 – 54	50 – 52

Fat	24 – 26	28 – 30
Protein	16 – 19	13 – 15
Lactose	2.0 – 2.2	2.2 – 2.4
Ash	2.0 – 2.3	1.9 – 2.1

Specification of *paneer* according to FSSR (2011)

Parameter	<i>Paneer</i>	Low fat <i>Paneer</i>
Moisture, maximum, %, (m/m)	60.0	60.0
Milk fat, %, (m/m), dry matter basis	50.0 (minimum)	15.0 (maximum)

Milk (preferably buffalo milk) is heated to about 90°C and coagulated at 70°C using mostly citric acid as coagulant. Whey is then drained through cloth lined hoops and pressing the coagulated to form blocks. Blocks thus formed are floated in chilled water for firming their body. The cow and buffalo milk mixed in the ratio of 50:50 having a fat content of 5% yields a superior product than cow milk alone.

Factors influencing the quality of Paneer:

- 1. Quality of milk:** Acidic milk having a titratable acidity of 0.2 to 0.23% LA yields a product with inferior quality. Homogenisation of cow milk is recommended to bring about improvement in the yield and to improve the organoleptic score of paneer.
- 2. Heat Treatment of milk:** Heating milk to 80°C for 5 min and cooling to 70°C before coagulation affects the sensory and microbiological quality of paneer.

3. **Type of coagulant:** Different coagulant like citric acid solution, one day old whey, 48 hr old sour whey, whey cultured with *L acidophilus* have been used to prepare paneer. In addition to this coagulant such as hydrochloric acid, phosphoric acid, tartaric acid and acetic acid have also been used in the manufacture of panner.
4. **Strength of coagulant:** Best quality paneer can be obtained using 1 % citric acid. Two percent citric acid also yielded good quality panner when cow milk is used. Satisfactory quality products are obtained when non-conventional coagulants like hydrochloric acid and acidophilus whey (0.6%) are used.
5. **Amount of coagulant:** For making good quality paneer from cow milk 2.34g citric acid or lactic acid is required for 1kg of milk while for buffalo milk 2.1 g of citric acid or lactic acid per gram is required.
6. **Coagulation Temperature:** Coagulation temperature of 70°C has been suggested to be most effective. However good quality paneer can also be prepared at a coagulation of 80°C from both the milk.
7. **pH of coagulation:** The optimum pH of coagulation is 5.35 for buffalo milk and 5.0 for cow milk.

The yield of paneer decreases with increase in the strength of coagulant, coagulation temperature and lowering the pH of coagulation in case of buffalo milk and it increases with increase in the coagulation temperature in cow milk paneer. The yield of paneer can also be increased by co-precipitation of casein and whey protein. Higher level of fat in paneer milk leads to lower yield of the

product in case of buffalo and cow milk. **Homogenisation** of paneer milk **improved the paneer yield.**

Chemistry of coagulation process in paneer:

The phenomena involves the formation of large structural aggregates of casein from the normal colloidal dispersion of discrete casein micelles, in which milk fat and coagulated serum proteins are entrapped together with whey. The major changes that takes place during coagulation are

1. The progressive removal of tri calcium phosphate from the surface of casein and its conversion into mono calcium phosphate and soluble calcium salt.
2. Progressive removal of calcium from calcium hydrogen caseinate to form soluble calcium salt and free casein
3. When the pH of milk system drops, the colloidal particles become isoelectric, i.e. the net electric charge becomes zero. Under such circumstances the dispersion is no longer stable; the casein gets precipitated and forms a coagulum.

The development of typical rheological characteristics of paneer could be due to preponderant and intensive heat induced protein – protein interaction. It is believed that β lactoglobulin and K- casein interact by sulphhydryl disulphide inter change when heated together. It is initiated at 65°C, increases up to 83% at 85°C and then decreases to 76% at 99°C.

KHOA

Khoa is a heat desiccated milk product. About 7-8% of the total milk produced in India is converted into khoa. It is prepared traditionally by desiccating milk in an open shallow pan with continuous stirring till a coagulation mass is obtained

which is worked up to form a pat. It is used as a base material for a large number of milk sweets such as burfi, peda, milk cake, kalakand, gulabjamun, etc. Three distinct types of khoa, namely, pindi, dhap and danadar are available in the country. These varieties differ in quality, texture, composition and specific usage. Khoa generally contains 17-20% protein, 22-25% lactose and 100-130 ppm of iron depending on whether it is prepared from cow, buffalo or mixed milk.

Specification of Khoa according to FSSR, (2011):

Parameters	Khoa
Total solids, minimum, %, (m/m)	55.0
Milk fat, minimum, %, (m/m), dry matter basis	30.0
Total ash, maximum, %, (m/m)	6.0
Titrateable acidity (as % lactic acid), maximum, %	0.9

Definition of Khoa:

According to FSSA (2006), khoa by whatever variety of names it is sold such as pindi, danedar, dhap, mawa or kava means the product obtained from cow or buffalo or goat or sheep milk (or milk solid) or a combination thereof by rapid drying . The milk fat content shall not be less than 30 % on dry matter basis of the finished product. It may contain citric acid not more than 0.1% percent by weight. It shall be free from added starch, added sugar and added colouring matter.

Buffalo milk is usually preferred over cow milk for khoa making, since the former gives higher yield and has a more desirable flavour, body and texture.

Different type of Khoa:

1. Pindi

It is characterized as a circular ball of hemispherical pat with smooth and homogeneous body and texture. This poses characteristic cooked flavour and is

preferred for the preparation of burfi and peda. It contains 19% moisture; 37% fat; 18% protein; 22% lactose and 3.6% ash.

2. **Danedar**

Granular texture and uneven body characterize this form of khoa. Usually 0.1% of citric acid (on product basis) is added during the heat desiccation process in shallow pan to obtain such texture. It has 20-25% fat and 35-40 % moisture. This forms base for the preparation of kalakand (granular texture), milk cake and granular milk solids.

3. **Dhap:**

It is characterized by loose and sticky body and smooth texture, attributable to higher moisture content and less intensive heat treatment. It contains about 20-23% fat and 37-44% moisture. It is preferred for the preparation of gulabjamun.



Dhap Khoa



Danedar Khoa



Pindi Khoa

Chemistry of Khoa

Khoa is essentially a matrix of heat denatured milk protein, in which fat, lactose; minor constituents and moisture are entrapped. Protein-protein reaction

and reaction with other milk constituents occur during desiccation. Lactose and protein that undergo Maillard browning and caramelization are significant in imparting typical flavour and desirable sensory characteristics to the khoa.

The main reaction in the preparation of khoa is the heat denaturation and coagulation of milk protein particularly the serum proteins and their interaction with casein and other constituents. Most of the albumin and globulins are almost denatured; the protective properties of the other colloids are destroyed early in the boiling process. Casein is also irreversibly denatured from colloidal state to non-dispersible state. The denaturation is accelerated by the incorporation of air and frothing during stirring. Total heat coagulation of protein occurs when the boiling mixture thickens to a buttery consistency in the pan.

Fat globules in milk, undergo subdivision and disrupts the fat globule membrane as a result of heat, vigorous agitation and scraping during the manufacture of khoa. Almost half of the globular fat is released as free fat, the extents of which depend upon the type and amount of fat content in the milk. Formation of free fat during transition from liquid phase to the semi-solid phase is very significant for the development of typical flavour, body and texture of khoa. The short chain fatty acids decreases, medium chain fatty acids increases and long chain fatty acids are unaffected during the preparation of khoa. The lactose is present in khoa mostly as supersaturated solution. Generally lactose does not crystallize out due to high viscosity and coagulations of proteins. However, large crystals of lactose are found in ordinary khoa.

A portion of milk salt is precipitated during preparation of khoa. Iron content, probably derived from heating pan, is raised considerably. Vitamin A, thiamine, riboflavin, ascorbic acid, nicotinic acid and folic acid are decreasing in the course of heating of milk for making khoa.

The deterioration of khoa is attributed to unhygienic methods of processing and subsequent improper handling, followed by lactose breakdown, proteolysis and

lipolysis due to activities of the mixed flora during storage. Being aerobic in nature, moulds cover the entire surface of the product kept under ambient conditions producing an abnormal colour, flavour and appearance.

Changes occurred during manufacture of Khoa:

1. Change in state
2. Change in intensity of colour
3. Change in milk fat
4. Heat coagulation of milk protein
5. Change in lactose
6. Precipitation of milk salts
7. Increase in iron content
8. Changes in vitamins

Chemical changes of khoa during storage:

Khoa has a low keeping quality at room temperature and develops rancid flavour. This may be due to fat hydrolysis which is due to lipase action. Mouldy surface developed during storage are due to high moisture content and excessively high humidity of storage room. When stored at low temperature (5 – 10°C) for long time staleness developed. There is an increase of various types of microorganism during storage at room temperature. The shelf life of khoa is about 2-4 days under ambient condition and 3 weeks under refrigerated conditions.