Abstract

Khoa also known as mava, khava or palghoa, is a partially dehydrated milk product, prepared by continuous heating and manual stirring-cum-scraping until it reaches a semi solid (doughy) consistency. Various physico-chemical changes occur in milk during khoa preparation. Heating results in denaturation of milk protein forming coagulated mass. Browning reactions viz. maillard (caused due to the interaction of lactose with protein) and caramelisation browning is induced in milk during khoa preparation. Elevated temperature also results in formation of heat degraded products. Microstructure of khoa as revealed by scanning electron microscopy consisted of protein agglomerated protein mass and void spaces in matrices. The shelf-life of khoa is two to four days under ambient conditions and three weeks under refrigerated conditions. Khoa is very liable to oxidative, microbial and physico-chemical deterioration during storage. The shelf-life can be enhanced by using vegetable parchment paper wrappers, plastic (polyethylene) film bags/pouches, laminated (preferably aluminium coated) pouches, tin plates, or cans in pack sizes. Several additives such as antioxidants (BHT and BHA), bacteriocins (nisin) and preservatives (sorbic acid and potassium sorbate and their salts) are also used to enhance shelf life of khoa.

Keywords: Khoa; maillard reaction, shelf life, scanning electron microscope, antioxidants

Introduction

Milk is considered nature's most complete food. It provides all the essential nutrients for the nourishment of human body. Due to its excellent nutrient profile, milk is consumed widely by people of all age groups. India, continues to be the largest producer of milk in world with 133.7 million tones in the year 2012-13 (Annual report, 2012-13). A considerable share of total milk production is utilized for production of milk based sweets as they have been an inseparable part of socio-cultural life of Indian subcontinent. It has also been reported that from the total milk production, 50-55% was utilized for production of indigenous milk products (Dairy India, 2007).

Depending on its characteristics, milk is eminently suitable for certain types of region specific indigenous traditional milk products. 5.5% of total milk produced in India is utilized for production of khoa (Kumari et al., 2012). It is top most dairy product consumed in India as compared to cheese and butter (Ezhil Raj et al., 2010).

Khoa, a heat desiccated traditional Indian milk product prepared by heat concentration of milk in an open pan with continuous stirring and scraping, is a major intermediate base for a variety of sweets like burfi, peda, kalakand, gulabjamun etc. (Acharya and Sapkota, 2008; Soumya et al., 2015). Cow milk khoa has moist surface, sticky and sandy texture as compared to buffalo milk khoa, which is not considered suitable for the preparation of milk based sweets (Mann et al., 2001). Cow milk was standardized to 4.0% fat and 8.5% milk solid not fat (MSNF) to prepare khoa. Various physico-chemical changes occur during conversion of milk into khoa which includes change in state of milk, change in colour intensity, homogenization of milk fat, free fat formation, heat coagulation of milk protein, lactose present as super saturated solution, partial precipitation of milk salts and increase in iron content (De, 2004).

Legal standards of khoa

As per Food Safety and Standards Authority of India (2011)
khoya 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 solids or a combination thereof by rapid drying. The milk fat content shall not be less than 30% on dry weight basis of finished product. It may contain citric acid not more than 0.1% by weight. It shall be free from added starch, sugar and colouring matter.

According to Bureau of Indian standards (1981), "khoa shall be heat coagulated milk product obtained by partial dehydration of milk of buffalo, cow, sheep and goat and their admixture. Milk solids suitably processed may also be used. It shall not contain any ingredient foreign to milk except the addition of citric acid in danedar khoa added to develop the desired characteristic. The composition and microbial standards for khoa are given in Table 1.

Khoa contains fairly large quantities of muscle building proteins, bone-forming minerals and energy-giving fat and lactose. It also retains most of the fat-soluble vitamins A and D and also fairly large quantities of water soluble B vitamins contained in the original milk. Additives to sweetmeats further increase the calorific value of the product (Aneja et al., 2002).

Traditional khoa making method

The manufacture of khoa is largely in the hands of private traders (halwais), who use highly primitive techniques essentially based on their experience. The scale of production is also too small, each batch comprising of about 4-5 litres of milk. The equipments used for manufacture of these heat-desiccated dairy products are made up of iron or cast iron or mild steel.

Milk in small lots, preferably buffalo milk is taken in an open pan (karahi) and boiled over brisk non-smoky fire. While boiling, milk is continuously and vigorously stirred with a circular motion by a ladle (khunti) to avoid burning of milk solids on the surface of the pan. Milk thickens progressively as the evaporation of moisture takes place constantly. When concentration reaches to about 2.8 fold in cow milk and 2.5 fold in case of buffalo milk, the thickened mass shows abrupt change in colour and consistency indicating that the coagulation of milk proteins has started taking place. It is stirred and scraped with the help of a scraper to avoid the scorching of milk solids sticking to the pan. The final product is ready when it shows signs of leaving the sides of the pan. This stage is called as pat formation and invariably should be achieved after moving the pan off the fire and by working the contents up and down (Pal, 2006a). The traditional method of khoa making requires large quantity of energy and in the present era, energy saving requires more attention.

In rural India, generally wood, cattle dung, coal, kerosene etc. are used in open chulah as fuel for khoa making which is hardly 8-10% thermally efficient. The traditional method of khoa making has a number of drawbacks such as: limited capacity due to batch operation, non-uniform product quality and thus not suitable for large volume production, Inefficient use of energy and low heat transfer coefficient results in bulky equipment, requires more manual labor due to lengthy process, Sometimes burning of the product occurs which lowers its quality (Kumar, 2013).

Khoa production methods and processes

A process was developed for manufacture of khoa using reverse osmosis (RO) and khoa prepared from RO concentrated whole milk (31% TS) was comparable in flavor and texture to conventional product with net energy saving of 335-430kcal/kg of milk (Dharampal and Cheryan, 1987). Cow milk was standardized to 4.0 fat and 8.5 milk solid not fat (MSNF) to prepare khoa by solar as well as traditional method. Before the dehydration of milk in solar cooker, cream was separated from milk by using electrically operated cream separator. After dehydration period was over, the milk from each vessel was measured and took in kadhai (that is, Iron shallow pan). At the same time calculated quantity of cream (previously separated and pasteurized) added and further stirring cum

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Types of khoa</th>
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<tbody>
<tr>
<td>Total Solids % by mass</td>
<td>65</td>
</tr>
<tr>
<td>Fat % min. (dry basis)</td>
<td>37</td>
</tr>
<tr>
<td>Total Ash, % by mass on dry basis, Max</td>
<td>6</td>
</tr>
<tr>
<td>Titrable acidity as lactic acid, % by mass, Max.</td>
<td>0.8</td>
</tr>
<tr>
<td>Coliform Count per gram, Max.</td>
<td>90</td>
</tr>
<tr>
<td>Yeast and Mould count per gram, Max.</td>
<td>50</td>
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</tbody>
</table>

Source: BIS (1981)
scraping process continued until desired body and texture of khoa were obtained. A uniform quality product in respect of flavour, body and texture, colour and appearance, overall acceptability and chemical quality was obtained by solar method (Dande et al., 2011). Lakshmi and Sailaja, 2012 reported that nutrient composition of khoa depends on the composition of cow milk which in turn depends on quality of fodder given to cow. Azolla, which grows in association with the blue green algae Anabaena azollae, is the most economic and efficient feed substitute for live stock which is very rich in proteins, essential amino acids, vitamins, growth promoter intermediaries and minerals (calcium, phosphorus, potassium, ferrous, copper, magnesium etc). Results revealed that the experimental diet containing azolla given to the cow had shown an increase in contents like moisture, carbohydrate, fat and protein in khoa sample over control diet, where as total solids found to be almost equal in both type of khoa.

Yield of khoa

The yield of khoa depends on several factors, including the type and quality of milk, the extent of dehydration, the type of khoa manufactured and its moisture content and handling losses (e. g. overflow, sticking residues, etc.). The moisture content is the most important factor responsible for the yield of khoa (Thakur and Joshi, 2002). Khoa prepared from buffalo milk has higher yield and better quality both in physical and chemical characteristics as compared to cow milk khoa (Gupta and Gupta, 2013).

Gross composition of khoa

For chemical composition of laboratory made khoa samples, a lot of variations can be observed in fat, total solids, protein, lactose, and ash content. Gross composition of laboratory made khoa sample is presented in table - 2

It can be seen from the table that the fat content in laboratory made khoa sample prepared from cow and buffalo milks ranged between 21.73 to 45.90 % with an average of 31.55 %. Similarly, for other parameters like total solids the value ranges from 63.29 to 80.80, protein 16.30 to 25.80, lactose 18.85 to 35.97 and ash 2.82 to 5.20 with an average of 73.05, 20.31, 26.88 and 4.04 respectively

Physico-chemical changes in milk constituents on conversion into khoa

Since khoa is essentially a heat desiccated product and hence served as the base for making various khoa based sweets. The steps employed for its production includes constant agitation and boiling of the milk in an open pan. These processing steps lead to the evaporation of water from milk, there by concentrating the milk.

The main reaction in the preparation of khoa is the heat denaturation and coagulation of milk proteins. Coagulation of milk proteins is brought about by heating to 132-136ºC. Albumin and globulins are coagulated below 100ºC, while casein (CN) is coagulated above 100ºC. Desirable heat induced chemical interactions result in reduction of redox potential and water activity which extends the product shelf life (Mann et al., 2008). Several heat induced changes takes place during khoa preparation. Other changes are an increase in acidity, maillard reaction between lactose and protein at elevated temperature and production of flavour compounds. The changes in milk components such as fat, protein, lactose, minerals and vitamins vary with the methods of preparation.

Fat content in milk influences the physico-chemical, sensory and quality characteristics of khoa. The percentage fat recovery in khoa decreases with the increased fat level in milk (Ranganadham and Rajorhia, 1989). It was observed that the combined action of scraping and agitation causes the rupture of fat globule membrane resulting in the release of higher amount free fat. Coagulation of membrane proteins also contributes to release of free fat from the fat globules. Hemavathi and Prabhakar (1973) isolated and identified methyl ketones and saturated aldehydes as major classes of carbonyls in khoa and burfi. Bhat and Ramamurthy (1982) isolated steam volatile monocarbonyls from skim milk as well as cultured milk by steam distillation method. He classified the monocarbonyls into methyl ketones, 2,4diens, and alk-2-enals. Methyl ketones were the major monocarbonyls class in steam distillates of both cow and buffalo milk fat.

Desiccation of milk during khoa making brings about changes in milk proteins. The major change in khoa making is the heat denaturation and coagulation of milk proteins, as evidenced by an abrupt change in colour and consistency of product towards the end of the process (Davies, 1940). De and Ray (1952) observed heat coagulation of cow and buffalo milk started at a ratio of concentration of 2.83 and 2.48 and ends at 3.57 and 3.05, respectively. Bonomi et al., (1988) observed that heating of milk affected number of hydrophobic sites on protein surface changes and also resulted in conformational modifications in proteins, including the exposure of previously buried hydrophobic sites which could thereafter interact and lead to protein aggregation and eventually protein precipitation. Carbonaro et al., (1996) reported that surface hydrophobicity of milk protein increased due to changes in dominant casein (CN) which may be affected by interactions between κ-CN and β-lg.Aneja et al.,(2002) observed that β-lg and α-la undergo coagulation and interacted with κ-CN during heating of milk. Rajorhia et al.,(1990) analyzed that heat coagulation of milk observed during the final stages of khoa making could be attributed to the destabilization of CN, altered salt balance and high temperature.

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Lactose is a major carbohydrate present in milk and milk products. It is a disaccharide consisting of one molecule of glucose and galactose and present in khoa in the form of a super saturated solution dispersed in the form of droplets. During heating two major changes are related to lactose. One is increase in acidity due to thermal decomposition and the other is the maillard reaction on heating of milk. Decomposition of lactose leads to the formation of compounds such as formic, acetic, propionic, pyruvic and lactic acid. Maillard type of browning is caused due to the interaction of lactose and protein at elevated temperature. The early maillard reaction is confined to the formation of the protein-bound amadori product "lactulosyllysine". Breakdown of the amadori product leads to the formation of furosine and hydroxymethylfurfural (HMF). Sahai (1990) reported high value of HMF indicating the vigorous maillard reaction and intense heat stress on milk during preparation of khoa. Lactulose is formed in heated milks by the alkaline isomerization of lactose catalysed by the free amino group of CN as reported by Richards and Chandrasekhara, 1960.

A rapid spectrophotometric analysis for quantitative determination of lactulose in heated milk and milk products was standardized by Adhikari et al., (1991) in which minimum of 10 mg/100 ml concentration of lactulose could be determined in high heated milk products. The reddish-brown colour produced on heating protein-free filtrate of heated milks containing less than 1.0% lactose and free of ions in 6.4 N sulphuric acid was used for quantitative determination of lactulose. The absorptivity of the coloured solution of lactulose at 330 nm was 14-fold more than that obtained from 62.5-fold more concentration of lactose and other aldoses.

The milk salts are regarded as the most important factor in the heat stability of milk. Heat treatment causes reduction of both the total soluble and ionic calcium. This reduction can be attributed to a conversion of soluble calcium to the colloidal state (Muldoon and Liska, 1972). Rajorhia and Srinivasan (1979) studied the distribution of minerals as affected by heat treatment during khoa preparation. He observed a remarkable reduction in the total as well as soluble calcium, magnesium and phosphorous. Storage of khoa at 30°C and at low temperature did not affect the relative distribution of these minerals. Boghra and Mathur (1991) studied the effect of heat on the soluble salts and found that acidification of cow milk resulted in shifting of all colloidal Ca, Na, K, Mg and citric acid into dialyzable form. A concomitant increase in the level of all minerals up to khoa stage was observed. The market samples of khoa contained 4-5 times more iron and about twice of zinc than laboratory made samples (Boghra and Mathur, 1996). They have concluded that iron and zinc entered as contaminants in

<table>
<thead>
<tr>
<th>Type of milk</th>
<th>Chemical constituents (%)</th>
<th>References</th>
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<tbody>
<tr>
<td></td>
<td>Fat</td>
<td>Total solids</td>
</tr>
<tr>
<td>Buffalo milk</td>
<td>45.9</td>
<td>80.8</td>
</tr>
<tr>
<td>Cow milk</td>
<td>34.8</td>
<td>74.4</td>
</tr>
<tr>
<td>Buffalo milk</td>
<td>37.1</td>
<td>80.7</td>
</tr>
<tr>
<td>Cow milk</td>
<td>25.9</td>
<td>74.4</td>
</tr>
<tr>
<td>Buffalo milk</td>
<td>21.73</td>
<td>68.8</td>
</tr>
<tr>
<td>Cow milk</td>
<td>26.05</td>
<td>70.05</td>
</tr>
<tr>
<td>Mixed milk</td>
<td>39.11</td>
<td>73.5</td>
</tr>
<tr>
<td>Mixed milk</td>
<td>22.44</td>
<td>66.13</td>
</tr>
<tr>
<td>Cow milk</td>
<td>34.14</td>
<td>76.85</td>
</tr>
<tr>
<td>Mixed milk</td>
<td>36.2</td>
<td>75.4</td>
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<tr>
<td>Buffalo milk</td>
<td>32.2</td>
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</tr>
<tr>
<td>Cow milk</td>
<td>22</td>
<td>69.1</td>
</tr>
<tr>
<td>Buffalo milk</td>
<td>32.28</td>
<td>70.5</td>
</tr>
<tr>
<td>Mixed milk</td>
<td>27.33</td>
<td>72.2</td>
</tr>
<tr>
<td>Buffalo milk</td>
<td>37.53</td>
<td>63.29</td>
</tr>
<tr>
<td>Buffalo milk</td>
<td>22.3</td>
<td>64.64</td>
</tr>
<tr>
<td>Buffalo milk</td>
<td>-</td>
<td>80.38</td>
</tr>
<tr>
<td>Cow milk</td>
<td>-</td>
<td>74.44</td>
</tr>
<tr>
<td>Range</td>
<td>21.73-45.90</td>
<td>63.29-80.80</td>
</tr>
<tr>
<td>Average</td>
<td>31.55</td>
<td>73.05</td>
</tr>
</tbody>
</table>

**Table 2** Gross composition of laboratory made khoa sample

Range 21.73-45.90 63.29-80.80 16.30-25.80 18.85-35.97 2.82-5.20 4.04
market samples usually through the iron and galvanized karahi and kunti used by the manufacturers.

Sapre and Deodhar (1988) reported that the retention of vitamin ranged from 72.2% for vitamin B2 and 81.6% for folic acid. The maximum loss was observed in case of vitamin B2 followed by ascorbic acid, vitamin B6, vitamin A and folic acid. Most of these losses were observed in the first stage (dhap) of khoa production. It might be due to more moisture content. Subsequent heating of dhap during the final phase resulted in only small additional losses, which ranged between 2.50 % for vitamin B2 and 6.4% for folic acid and 18% in vitamin A.

Heat induced changes in microstructure and texture of khoa:

Scanning electron microscopy (SEM) study of heat induced changes during khoa making revealed that continuous boiling of milk during khoa preparation led to gradual coalescence of casein-whey protein complexes to a fuzzy agglomerated mass precipitating out as large interlinked gritty particles. SEM of cow milk khoa (Fig.1a) revealed agglomerated protein-lactose complex, inter linked together with thick bridging material with minimal void space while buffalo milk khoa (Fig. 1b) had loose matrix with uneven surfaces and voids. In case of mixed milk khoa (Fig. 1c) compact agglomerated protein lactose complex was observed. It had a slightly denser matrix than buffalo milk (Adhikari, 1992).

Gupta et al., (1990) found increase in total solids was accompanied by a considerable increase in Instron hardness, gumminess and chewiness but decrease in cohesiveness of khoa. Significant inter-relationships among texture profile parameters, particularly between hardness and cohesiveness, gumminess and chewiness and also between cohesiveness and all other parameters indicating that one or two most important texture profile parameters could probably serve as an index of texture profile of khoa. Interrelationships among texture, composition and microstructure of buffalo milk khoa and gulabjamun were investigated by Adhikari et al., (1994). He reported that Instron hardness, gumminess and chewiness were negatively correlated with moisture and fat contents, but positively with protein, lactose, added carbohydrates, ash and calcium content for both khoa and gulabjamun.

Factors affecting quality of khoa

Type of milk

The quality of khoa depends on type of milk. Cow milk produces pale yellow colour in the dehydrated product while buffalo milk gives it a colour, which is light greenish-white. De (2004) reported 18.3% yield from pure cow milk, 21.6% yield from pure buffalo milk and 20.0% from admixture of cow and buffalo milk at 1:1 ratio. The yield of khoa is closely proportional to the percentage increase in total solids than fat. Hence, buffalo milk is preferred for its high total solids content.

Ranganadham and Rajorhia (1989) reported that khoa manufactured from buffalo milk yielded more free fat than obtained from cow milk. Cow milk gave a product with sticky body leading to lower sensory scores than khoa prepared from buffalo milk. Khoa made from buffalo milk on the other hand has a soft body and smooth texture and is highly suitable for sweets making because of high fat content. Buffalo milk fat contains high amount of unsaturated milk fat of long chain which results in high free fatty acids (FFAs). Stickiness in cow milk khoa was attributed to insufficient release of free fat (Vogra and Rajorhia, 1983).

Desiccation conditions

Khoa is prepared by continuous boiling of milk until desired concentration of solids (65-70%) is reached. De (2004) standardized the method of preparation of khoa. The recommended temperature of evaporation was boiling point of milk till pan contents reach a pasty consistency and then lowering the temperature to simmering temperature (85°C to 90°C). Higher evaporation temperature at the later stages of khoa preparation leads to the development of undesirable characteristics. Temperature below the optimum produces undesirable colour and appearance, flavour, body and texture; besides being more time consuming.

Fat/SNF Ratio

De (2004) reported that with the increasing amount of fat in milk, the moisture content in khoa decreased irrespective of type of milk. He reported that if fat in milk was relatively more than certain minimum level (cow milk 4% and buffalo milk 5%) then it leads to more moisture being removed. On the other hand if SNF in milk is relatively less than a certain minimum level (cow milk 4% and buffalo milk 5%) then the degree of dehydration must necessarily be less. Therefore, moisture content in khoa varies directly with the ratio of SNF/Fat. The loss of total solids in handling cow or buffalo milk is due to milk solids sticking to surface of karahi prior to pat formation that are difficult to scrape. Fat percentage in raw milk progressively increased the loss of total solids, which reduced gradually until a minimum is reached with milk testing 4 % fat for cow milk and 5% fat in buffalo milk, respectively. The optimum level of fat for maximum recovery of solids in khoa varies with the ratio of Fat/SNF. Presence of more fat in either type of milk than the optimum causes a sharp rise in the percentage loss of total solids. It was also observed that separated milk of either type gives an unsuitable product. A progressive increase in the fat level of milk induces a gradual
improvement in product.

Milk Acidity

Prakash and Sharma (1984) observed acidity of milk increased when milk was converted into khoa. Fresh milk resulted in khoa with good sensory and quality characteristics. Pindi khoa can only be made from fresh milk having acidity in the range of 0.14 to 0.16% as lactic acid. More than 0.17% acidity in milk produces khoa with grainy texture. The size and hardness of grains increased with the increase in acidity. However, for the manufacture of danedar khoa, acidity upto 0.18% developed by addition of an acidulant is optimum. In addition to grainy texture, khoa prepared from high acidity milk, developed due to natural souring, had acidic/sour flavour. Such khoa is not suitable for manufacture of good quality sweets.

Stirring speed

Continuous stirring of milk during khoa making is very important and stirring speed should be optimum for good quality khoa. According to De (2004) low speed of stirring (30 - 40 rpm) resulted in an undesirable texture and flavour in khoa. Medium speed of stirring (96 - 100 rpm) make the product highly suitable for preparation of khoa based sweets. High speed of stirring (150 - 160 rpm) resulted in high oiling off in the product, which is not desirable.

Homogenization of milk

Normally milk is no homogenized for khoa making. However, under certain circumstances, such as use of recombined milk or for increasing the fat by adding butter oil or butter, homogenization of milk becomes essential. Khoa prepared from homogenized milk is brittle and lack cohesiveness as fat globules are subdivided to a finer size, the surface area increases relative to the volume. In case of milk fat globules, there is no longer sufficient membrane material to cover the new surface. The fresh fat surfaces represent an attraction for the hydrophobic side of the sub micelles, and they now coat the fat globules forming a new membrane. Notice, that it is only a small portion of the micelles, which are needed for the coating; the majority of the micelles remain intact. The moisture retention in such khoa is also more, which results into softness and higher yield (Pal, 2006a).

Neutralized milk and its effect on quality of khoa

Due to unhygienic conditions, initial microbial load, poor milk quality, lack of transportation facilities of milk from production centers to the processing plants soon after milking and limited cold storage leads to development of acidity which further reduces the shelf life of milk. Middlemen add neutralizers like alkali bicarbonates, carbonates and hydroxides which improve the shelf life of milk by neutralizing the developed acidity (Soumya et al., 2015). Addition of neutralizers can cause increased mineral concentration in body fluids and soft organs leading to kidney stone development and commercial preparation of neutralizers might even be contaminated with heavy metals like arsenic, lead, etc. Continuous use of such milk and milk product may cause health hazards (Satoskar et al., 2000). Since the frequency and quantity of milk consumed by infants and children are much more compared to adults, the health risk is more for them (Soumya et al. 2014).

Zariwala et al., (1978) collected 551 khoa samples from various retail dealers and reported that the majority of samples had a very hard and granular texture with dirty white or grey colour exhibiting bitter or salty taste. These characteristics may be attributed to the use of high acid milk or addition of neutralizers. Ghatak and Bandyopadhyay (1987) reported that out of 35 samples of milk collected from local milk vendors in Kalyani, sodium carbonate was present in 7 samples. Kumar (1999) reported 2 out of the 4 brands of skim milk powder collected from Delhi and Haryana to be positive for neutralizers. The effect of neutralizers on the physico-chemical properties of milk and milk products was studied by Rajput (1982). He reported that neutralized milk and milk products had yellowish colour, loose body, sticky texture, salty taste and sour smell. Khoa prepared from slightly sour milk had acidic smell, salty taste, increased gumminess and chewiness, coarse structure with increased acidity and greater grain size. Hardness of grain led to poor body and texture which was not suitable for preparation of sweets (Rajorhia et al., 1990). Neutralized milk produces grains of very small size or no grains at all. Khoa made from neutralized milk has either salty or soapy or sour flavour, depending on the extent of neutralizer used and the level of souring (acidity) in milk before neutralization. The moisture retention in khoa prepared from neutralized milk was higher and this resulted in a higher yield (Pal, 2006b). A recent report in the "The Times of India" (2012) had the doctors urging people to avoid adulterated khoa for safer and healthier life. Consumption of such product may increase blood pressure during delivery and could even lead to strokes. It could even damage the liver and kidneys and ultimately prove to be fatal. According to a report published on Oct.15th, 2009 in 'Daily News and Analysis' 400 kg of adulterated was recovered from Greater Noida. 43 kg of adulterated was seized ahead of Diwali celebration from Gurgaon (The Times of India, Nov. 4th, 2010). PFA officials seized 300 kg while conducting regular check in wholesale market in Moti gate area of New Delhi (The Hindu, Oct.25th,2011).20 quintal adulterated based sweets were recovered in Jaipur and sweets worth Rs 12 lakh was found in Thane (IBN live, Oct. 15th,2012). On Oct.20th (2012) 'Hindustan Times' also reported 1,000 kg of adulterated was seized by PFA officials from Firozpur, Haryana. Recent reports
also point towards large scale adulteration of khoa. On Nov. 11th (2012), 'The Times of India' reported the seizure of adulterated khoa from sweets shops in Allahabad. Further, Business standards on Nov. 12th (2012) also reported the seizure of adulterated khoa from Ghaziabad.

Storage and shelf life studies on khoa:

Khoa has low keeping quality at room temperature. Rajorhia and Srinivasan (1979) reported shelf life of 3 days at room temperature and 14 days under refrigerated conditions. During storage, rancidity increased due to free fatty acids in khoa. Even though the khoa and khoa based milk sweets are produced under strict hygienic conditions in organized sector, they are prone for microbial contamination. It may gain entry into food at any stage of processing right from the farm to till the food is reached to the final consumer like at the time of packing, transport and storage etc, so it becomes imperative not only to take all kinds of preventive measures and also to evaluate at every stage (Agarwal and Rachappa, 2006) Dairy products prepared under unhygienic conditions pose a great threat to the health of the consumer. Khoa is perishable food product and has short shelf-life. The high nutritive value and high water activity (0.96) of khoa is conducive to growth of bacteria (Sawhney et al., 1994). Staphylococcus aureus and Bacillus cereus are main bacteria responsible for food borne illness in khoa. The microbial quality of khoa is initially good during the time of production and decreases gradually with storage and marketing. The presence of molds in khoa causes its fast deterioration by producing discoloration defects as well as disagreeable flavors. Efficacy of solar radiation on germicidal influence on khoa during storage was observed by Chavan et al., (2006a). He reported that solar radiation has a definite role insignificant reduction of yeast and mould counts. Solar energy and microwaves techniques exhibited germicidal and micro biostatic property during its application in khoa storage and were reported as an ideal and promising techniques for preservation of dairy products like khoa (Chavan and Kulkarni, 2006b).

A study of various constants of fat extracted from khoa had been made by Narang (1969). He reported that khoa started to deteriorate and gave out a rancid flavour within 48 h when kept at room temperature. Butyro refractometer reading and reichert-meissl value showed a decreasing trend while polenske value increased. Iodine value and saponification value was found to be constant. Free fatty acids values showed a marked increase. Boghra et al., (1991) studied the effect of heat on the soluble salts of milk and found that acidification of cow milk resulted in shifting of all colloidal Ca, Na, K, Mg and citric acid into dialyzable form. A concomitant increase in the level of all minerals up to khoa stage was observed. Decrease in pH, increase in acidity, FFAs, peroxide value, tyrosine value was also observed during storage at 10°C/30days. Studies on lipids isolated at various stages during preparation of khoa from cow and buffalo milk was conducted by Arora (1978). He observed an increase in total phospholipid, carbonyl and decrease in FFAs at various stages during preparation. The fatty acid composition of khoa was analysed by capillary gas chromatography (GC) and compared with those obtained with cow milk, buffalo milk and toned milk. Among the samples analysed, 57% showed fatty acid composition characteristic of milk fat. The ratio of major saturated fatty acids to unsaturated fatty acids (S/U) including 18:1trans fatty acids were calculated for all the fats. The GC profiles of 43% samples showed the composition of fatty acids not conforming to milk fats (Amruthakala, 2012).

Methods to increase shelf life of khoa

The critical point for the deterioration of khoa was identified as air tight packaging. This problem can be minimized through changing the packaging material to muslin cloths which allows free air flow and reduced anaerobic microorganism growth (ICMR, 2000). In the absence of proper packaging, the rate of chemical deterioration of khoa such as oxidation and browning

Figure1: SEM of cow, buffalo and mixed milk khoa

(P- denotes protein lactose complex, v- denotes voids present in protein)
increases. Use of ply laminated pouches and tin containers increased the shelf-life of khoa (Ramzan and Rahman, 1973). Jha and Verma (1988) observed increased storage stability of khoa for 40 days by addition of potassium sorbate. Wadhawa et al. (1993) stated that the storage life of khoa can be enhanced by using different types of food preservatives and antimicrobial agents.

Rao et al. (1977) studied the effect of different levels of potassium sorbate on keeping quality of khoa at 30°C and at 5°C. They found that the packaging materials impregnated with 20% potassium sorbate solution and injection of nitrogen into tins containing khoa enhanced shelf-life up to 10 and 18 days at 30° and 5°C, respectively. Concentration less than 20% was not effective. Kalra et al., (1977) observed that khoa samples stored with nisin up to 28, 42 and 90 days at 30°C, 22°C and 10°C showed no bacterial counts which maybe attributed to the combined bacteriostatic and bactericidal properties of nisin against microflora of khoa. Under rule 55 of PFA Rules (1955), sorbic acid and its salt of sodium/calcium/potassium are permitted @ 2000 ppm in paneer/chhana (Mahindru, 2000).

Rehman and Salaria (2006) reported the effect of synthetic antioxidants on storage stability of freshly prepared khoa. FFA, peroxide value and Iodine value were used to assess the development of rancidity during 30 days of storage of at 25°C and 45°C. Butylatedhydroxy anisole (BHA) and butylatedhydroxy toluene (BHT) were added to freshly prepared khoa to extend the storage life, results illustrated that synthetic antioxidants inhibited the development of rancidity during storage of khoa. Shelf life was easily extended to 30 days by the addition of BHA or BHT.

Packaging of khoa

Packaging is the integral part of the processing in food industry. Packaging serves as the vital link in the long line of production, storage, transport, distribution and marketing. A scientifically designed package should afford protection against moisture loss, flavor loss, oxygen, microbial and fungus attack apart from being compatible with food. Bhat et al.,(1948) suggested a method for steaming of khoa for 15 to 20 min to prevent the spoilage of the product. Rudreshappa and De (1971) reported that the laboratory made khoa samples with an initial moisture content of 20-25% and warm packaging (80°C-90°C) at the time of packaging in tin cans ensured a maximum shelf life of 14 days at 37°C, whereas packaging at 25°C to 30°C affected the acceptability adversely, rendering the canned product unmarketable. Rao et al., (1977) reported that khoa packaged in tin cans stored at 5°C were of satisfactory quality after 60 days; khoa in aluminium foil / polyethylene remained satisfactory for 30 days. Kumar et al., (1977) found four ply aluminium coated laminates proved best for packaging of khoa followed by two-ply packs, high density polythene and parchment paper. It was observed that khoa samples packed in parchment paper and HDPE were reported to be acceptable up to 5 and 14days at 8°C±1°C, whereas laminate packaged samples were observed to be of satisfactory grade for more than 5 days at 37°C, 30 days at 8°C±1°C and more than 75 days at sub-zero temperature. Goyal and Srinivasan (1989) studied the effect of four different flexible packaging materials viz. P1-posterpaper/aluminum foil/LDPE 55 - 60 gm/sq.m., 0.02 mm and 150 gauge, P2-poster paper/ aluminum foil/LDPE (55 - 60 gm/sq.m., 0.009mm, 150gauge ; P3-MST cellulose film/LDPE 300gm/sq.m. and 150 gauge and P4-tin cans on the chemical quality of khoa stored at 37± 5°C and 60% relative humidity (RH) for 0, 5, 10and 15 days. Khoa samples packaged in tin cans (P4) showed the least chemical changes exhibited by the samples packed in the packaging materials P1, P2 and P3 respectively. They reported that the greatest decrease in moisture content of the khoa samples occurred for the packaging materials (P3) due to permeability of moisture vapor. The smallest decrease in moisture content occurred for the (P4) tin cans; which were completely impermeable to moisture ingestion. It was also observed that the significant differences in the values for different packages (P1, P2, P3 and P4) were perhaps mainly due to differential growth of acid producing microorganisms. Kumar et al., (1977) observed that laminates containing aluminum foil provide good protection against moisture losses because of their superior moisture barrier properties. Acharya and Agrawal (2010) reported when freshly prepared khoa was stored at room temperature (25±1°C) and refrigerated temperature (5±1°C) by using different packaging materials such as LDPE, aluminum foil/PVC and three layer laminated (polyester/met.BOPP/LDPE) in different conditions viz. normal and shrink. All of the packaging materials on both conditions showed no significant difference except normal LDPE on mean sensory score and chemical parameters of khoa during storage at 5±1°C whereas it showed highly significant difference at 25±1°C among three packaging materials. Three layer laminated sample showed significantly higher sensory quality, high pH, low acidity, peroxide value (PV), free fatty acids and lower microbial count than other two packaging materials. Similarly, shrink packaged sample showed better quality in terms of sensory and microbial attributes of khoa compared to normal packaging. No colonies of yeast and mold, coliform were observed during the storage period. Shrink packaged khoa in three layer laminated increased storability to 27 days at 25±1°C against three days for unpacked ordinary khoa.

Conclusions

A considerable share of total milk produced in India is utilized for khoa preparation. It forms an important base material for preparation of varieties of milk sweets which are integral part of Indian food heritage. As there is no strict quality parameters
prescribed to khoa, so adulteration is common practice and occurs in every step of manufacture and marketing of khoa and khoa based dairy products. Marketing of khoa in an organized sector and high price of the commodity often makes it susceptible to adulteration to gain economical benefit. There is a wide variation in the chemical composition and yield of khoa due to the use of varied techniques by khoa manufacturers. Hence there is a need to adopt standard procedure for khoa manufacture. A need for change in PFA definition seems inevitable. To elucidate a new standard for khoa, there is need for fundamental study regarding the factors affecting physicochemical and microstructural changes occurs during khoa manufacture, as influenced by type of milk. In India, stringent measures should be execute to ensure strict adherence of hygienic practices during khoa manufacture at small scale, unorganized sector to ensure public health safety and adequate shelf life of product.

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