THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
Dec 2023 3(12) 4155-4160

Monograph

Quality of milk and Physico-Chemical Properties of Khoa

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https://doi.org/10.5281/zenodo.10372017

1. Introduction

Khoa, khoya, khowa or mawa is a traditional dairy product is widely used in the cuisines of the Indian subcontinent, Bangladesh, Nepal and Pakistan. Mawa 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 percent on dry weight basis of the finish products. It may contain citric acid not more than 0.1% by weight. It shall be free from added starch, added sugar and added colouring matter (FSSAI, 2011). Khoa is a heat-desiccated Indian traditional milk product prepared by continuous heating of milk until the desired concentration of milk solids about 60–70% is achieved (Kumar *et al*. 2016). The Bureau of Indian Standards has provided legal standards for different types of Khoa like Pindi, Dhap and Danedar in terms of fat, total solids, ash, acidity, coliforms and yeast and mould counts (IS 1980). These varieties are used for making value added khoa based milk products like peda, burfi, kalakand, gulabjamun etc. (Choudhary 2015; Choudhary *et al*. 2017).

2. Quality of milk

This influences the body, texture and flavour of the khoa. The important factors of quality of khoa are-

(a) Type of milk
(b) Fat percentage of milk
(c) Acidity of milk
(d) Adulteration of milk
(e) Homogenization of milk.

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Published 13.12.2023

(i) **Type of milk** – Buffalo milk is preferred for khoa making. Khoa from buffalo milk is considered distinctly superior, being whiter in colour having soft and loose body and granular texture. These characteristics are considered desirable for making high quality sweets. The yield of khoa also depends upon the type of milk used. The yield of khoa from cow milk is around 18.0% and from buffalo milk is 20%, when milk is standardized to 4.5% fat and 8.5% SNF.

(ii) **Fat percentage in milk** – A minimum fat level of 4.0% in cow milk and 5.0% in buffalo milk is necessary to obtain a desirable body and texture in khoa so as to make it acceptable for use in sweet making. A low-fat level of khoa produces hard body and coarse texture in the finish product and high fat level of khoa produces improves the quality of khoa to certain extent. Very high fat milk produces free fat which is undesirable as it reduces the keeping quality causing off flavour during storage.

(iii) **Acidity of milk** – Fresh sweet milk yields the best result of khoa, while developed acidity in milk progressively tend to produce an undesirable sour flavour and coarse texture in the khoa. Neutralization of acid milk improves the texture, but do not improve the flavour of khoa.

(iv) **Adulteration of milk** – Adulteration of milk with starch produces hard the body of the finish product, which is rendered less suitable for sweet making. Milk adulterated with sugar gives an intense brown colour product.

(v) **Homogenization of milk** – Homogenization of cow or buffalo milk produces a softer body in khoa and also show less fat linkage, less browning but a reduced patting tendency is observed.

3. Physico-chemical change in milk on conversion into khoa

The physico-chemical changes in milk on conversion into khoa, there are many factors affecting quality of khoa, it depends on desiccation conditions, type of milk, fat/SNF ratio, lactose content etc. Khoa made from cow milk is sticky due to insufficient release of free fat whereas that made from buffalo milk has a soft and smooth body and is highly suitable for khoa based sweets because of high fat content (Vogra and Rajorhia, 1983). Khoa prepared from buffalo milk has a mildly cooked, rich nutty flavour and sweet taste and granular texture. The effect of quality of buffalo milk on compositional basis and physico-chemical parameters of khoa during storage condition has been assessed (Choudhary, 2019).

Physico-Chemical Properties of khoa are given below

3.1 Change in state –The liquid milk is converted into semi-solid mass due to evaporation of water of milk. The partial dehydration of water causes coagulation of milk proteins, partial separation of fat, interaction of milk carbohydrate with protein and separation of minerals and lactose. All the constituents including lactic acid, increase in the proportion to the degree of concentration.

3.2 Change in the intensity of colour – Due to prolong heating of preparation of khoa, the white colour of milk changes to light brown colour. This is due to formation of Melanoidin pigments. This browning is due to interaction between aldose group of lactose and amino group of casein termed as Maillard reaction (Sukumar De, 2019).

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3.3 Heat coagulation of proteins

(i) Whey proteins, particularly β-lactoglobulin and α-lactalbumin tend to undergo varying degree of denaturation, aggregation and coagulation as the temperature of milk rises above 77°C (90°C in case of buffalo milk) and their interaction with k -casein begins.

(ii) The denaturation of whey proteins results in production of sulfhydryl (-SH) compounds, which gives rise to cooked flavour in khoa and other heat desiccated products.

(iii) Casein is quite stable at high temperature, the combined effect of severe heat treatment and concentration and complexing whey protein with it, substantially increases the size of casein micelles. This results into loss of stability of casein micelles. The consequent coagulation of casein tends to increase at a constant temperature of heating with milk solid concentration.

(iv) The precipitation of casein at Total Solid concentrations in khoa making is due to (i) reduction of pH (ii) due hydrolysis of organic phosphate and through precipitation of primary and secondary calcium phosphate (iii) due to loss of hydrophilic character of k-casein.

(v) Coagulation of casein and aggregation of whey proteins cause entrapment of parts of the fat in these aggregates. The moisture also disperses as fine droplets in the aggregates of proteins. Interaction between heat denatured β-lactoglobulin and κ-casein via disulphide bonding is partly responsible for the pH-sensitive coagulation behavior of milk. The α-lactalbumin component of milk has an almost similar effect on heat coagulation. All these changes may be important in the heat coagulation during the final stages of khoa making process. The coagulation of milk occurs at the air-milk interphase and not in the underlying layers, when the milk is being desiccated either by the batch process or the continuous process of khoa making (Prakash and Sharma 1984).

3.4 Homogenization of milk fat

Homogenization of milk fat, the fat milk globules are sub divided into smaller units due to vigorous agitation at high temperature.

3.5 Free fat formation

Considerable amount of free-fat is produced due to rapture of fat globules membrane by scrapping action of the stirrer, at elevated temperature.

3.6 Super Saturated solution of lactose

Due to evaporation of water, the concentration of lactose increases and finally in khoa lactose is present in super saturated form. Which on cooling, a portion of it crystallizes (Ladkani and Mulay, 1974).

3.7 Partial precipitation of milk salts

Heating at high temperature causes conversion of soluble calcium and magnesium salts into insoluble form that lead to their interaction with protein component.

3.8 Increase in Iron content

The initial iron content of milk is 2 to 4 ppm and after heating of vigorous agitation of khoa in karahi, the iron content of khoa exceeds 100 ppm. The additional iron comes from the surface of the karahi due scrapping action of khunti.

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4. Yield and over- run of khoa

The yield of khoa is variable and influenced by the following factors.

4.1 Type of khoa

Type of khoa which have the higher moisture content show a higher yield if the milk of same T.S. has been used for the manufacture of all types. In general, Dhap type khoa have a higher yield as compare to Danedar and Pindi.

4.2 Type of milk

Cow or buffalo milk, influences the yield by the total solid content. Buffalo milk with higher total solid content gives a higher yield of khoa than cow milk with lower total solid content.

4.3 Quality of milk

The quality of milk refers to total solid content. High quality milk means the milk with higher total solid content, which yields higher quantity of khoa as compared to poor quality milk with a low total solid content.

4.4 Extent of dehydration

This means that the percentage of moisture retained in khoa. More the dehydration, lower will be the yield & vice-versa.

5. Requirements of high grade khoa

Only fresh, sweet clean milk, free from colostrum and in every way fit for human consumption shall be used. The milk shall be free from adulterants, preservatives and any matter foreign to milk is required for khoa preparation. The fat percentage of milk shall be such that the final product conforms to the legal requirements. This should have a uniform whitish colour, soft body, a smooth granular texture, a rich nutty flavour . It should be free from any off flavours and surface dryness.

- **Appearance and colour** – Khoa shall be free from free fat, water seepage and mould. The colour of khoa shall be white to pale yellow may be with a tinge of brown.
- **Odour and flavour** – Khoa shall have its characteristic flavour. It shall be free from objectionable flavour and odours.
- **Texture and consistency** – The khoa shall conform to its type and designation. It shall have uniform texture and consistency. The surface of the khoa should not appear dry and nor should it be sandy.

6. Keeping quality of khoa – Keeping quality of khoa is influenced by the following factors

(i) Temperature of storage
(ii) Quality of raw material
(iii) Initial moisture content
(iv) Sanitary conditions observed during manufacture
(v) Type of packaging
(vi) Method of packaging.

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(i) **Temperature of storage –** With increase in storage temperature of khoa, the keeping quality of khoa decreases. The average shelf life of khoa at 37°C, $8^0 \pm 1^0$C and – 20^0C were observed to be 5, 30 and 75 days respectively.

(ii) **Quality of raw material –** Fresh, sweet milk produced under sanitary conditions should be used for khoa making. Any developed acidity produces, lowers the keeping quality of khoa.

(iii) **Initial moisture content –** Higher moisture content in the finish product of khoa reduces the keeping quality of khoa.

(iv) **Sanitary conditions observed during manufacture –** Since khoa is produced in the open under existing system of production, the sanitary conditions observed during manufacture will certainly play an important role in influencing keeping quality. Better the sanitary conditions higher its storage life and vice-versa.

(v) **Type of package** – The type of package as specified by packaging material, influence the keeping quality of khoa. Khoa samples (500 gms) showed an average shelf-life at 8 ± 1^0C of 14 days and 30 days for parchment paper/polyethylene flim and 4 ply aluminium coated laminates respectively.

For better keeping quality of khao, there are some chemical preservatives are added to prolong the shelf life of khoa. Potassium sorbate, sodium metabisulphite and nisin chemical preservatives are added to enhance the shelf life of khoa.

Table 1. Common chemical preservatives on shelf-life of khoa

Preservative	Level	Shelf-life
Potassium sorbate	0.2 – 0.4%	14 days (ambient)
Sodium Metabisulphite	1000 ppm	14 days (ambient)
Nisin	0.02%	21 days (ambient)

(Aneja R.P. *et al*., 2002)

7. Uses of khoa

(i) As a base and filler for preparation of large number of Indian sweets e.g. gulabJamun, peda, burfi, kalakand etc. Peda is sweetened khoa formed into balls or thick disks with flavouring agents like saffron and/or cardamom added.

(ii) For direct consumption of khoa with added sugar.

8. Conclusion

Buffalo milk is preferred for khoa making. Khoa from buffalo milk is considered distinctly superior, being whiter in colour having soft and loose body and granular texture as compared with cow milk. Khoa is used in various types of sweets. Peda is sweetened khoa formed into balls or thick disks with flavorings such as saffron and/or cardamom added. Gulab jamun, also a round ball sweet made from khoa and then deep fried and soaked in rose water flavoured sugar or honey syrup. Barfi is also flavoured, but khoa is not the only ingredient.

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