

Preparation of Khoa by Traditional and Mechanical Methods

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ABSTRACT

In the present study a comparison between preparation of khoa by traditional method as well as in mechanical method using steam jacketed khoa pan was carried out. Khoa was prepared by traditional method by stirring the raw milk continuously in a pan over a flame until the raw milk was converted into semi solid stage. The drawbacks such as vary in temperature during the experiment because of non-uniform distribution of flame and burn out of milk solids were identified in this method. This leads to burnt flavor and discoloration of khoa. To overcome these drawbacks of traditional method, khoa was made in a steam jacketed khoa pan installed at Dairy and Food Processing Pilot Plant, College of Agricultural Engineering, Madakasira at a uniform pressure of about 1.5 kg/cm². In this mechanical method, the khoa was prepared in less time as well as it has good appearance, flavor, texture compared to khoa prepared by traditional method. In traditional method, about 0.242 kg of khoa was obtained from

0.94 kg of raw milk with addition of 0.0925 kg of sugar while 11.50 kg of khoa was obtained from 40 l of raw milk with addition of about 4 kg of sugar when khoa was made in steam jacketed khoa pan.

Keywords Milk, Khoa, Traditional method, Mechanical method, Khoa pan.

INTRODUCTION

India is the world's largest producer of milk and dairy products, accounting for about 13% of world's total milk production Verma and Lal (1989). Major portion of India's economy is based on agriculture and animal husbandry where in milk production plays vital role. India ranks first in production of milk in the world followed by United States, China and Germany. Milk Production in India was around 146 million tonnes in 2014-15 according to NDDB. Moreover,

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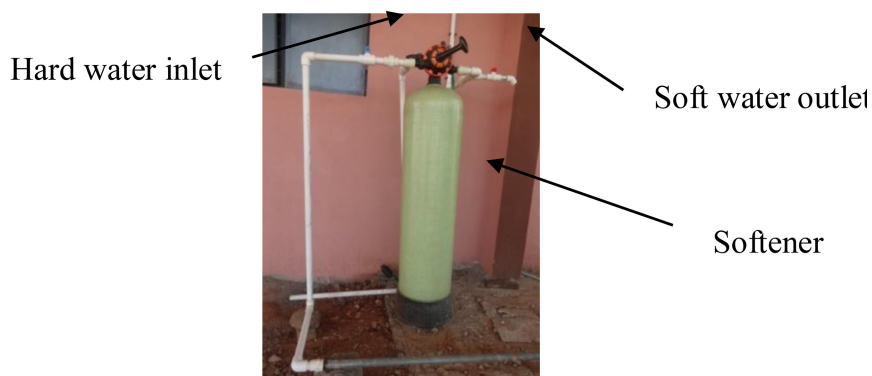


Fig. 1. Softener installed at dairy and food processing pilot plant.

with change in consumer demands along with raw milk, value added milk products became the need of the hour. Now-a-days value added milk products like khoa, ice cream, flavored milk, butter milk are in peak demand Kumar (2013).

Khoa or Mawa is an important indigenous heat coagulated, partially dehydrated milk product which is very popular in large section of population throughout the country. It is obtained by heat desiccation of whole milk to 65 to 70% milk solids without the use of any foreign ingredients.

According to Prevention of Food Adulteration Act, khoa is the product obtained from cow or buffalo milk or a combination thereof by rapid drying containing milk fat content not less than 30% on dry weight basis of the final product (Reddy 2007).

For khoa making, generally traditional method is followed in which milk is heated in an open pan and continuously stirred and scraped with the help of a scraper to avoid milk solids sticking to the pan. It is estimated that about 6 lakh tonnes of khoa is produced annually, which is equivalent to seven percent of India's total milk production (Rajarajan *et al.* 2007). Depending on the end use and the quality of milk used, mainly three commercial types of khoa are identified namely pindi, dhap and danedar which differ in composition, texture and quality (Sawhney *et al.* 1984). Khoa is of great commercial importance due to its use for the preparation of a variety of indigenous sweets like burfi, peda, gulabjamun. The traditional

method of khoa making has a number of drawbacks: It has a limited capacity due to batch operation which results in 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, large spillage losses, it requires more manual labor and sometimes burning of the product occurs which lowers its quality.

In order to overcome the above mentioned drawbacks, many attempts have been made by various researchers towards mechanization of khoa making machine More (1987). Hence the objectives of the research is to prepare the khoa in a mechanical method and compare the quality of khoa obtained in traditional method.

MATERIALS AND METHODS

Equipments used in dairy processing plant

Equipments used in dairy processing plant were softener, steam boiler and khoa pan Verma (1988).

Softener

Softener eliminates the salts responsible for hardness from water, namely calcium and magnesium. In the softener there are millions of tiny polymer beads (resin) which carry a sodium ion charge. As the water flows over this resin, sodium ion thereby softens the water. The capacity of the softener (Fig. 1) is about 100 l.

Table 1. Specifications of boiler.

Maximum rated heat output	150 kg/hr
Thermal efficiency	65% ± 2%
Fuel consumption	24.0 kg/hr
Dry weight	600 kgs
Overall Dimensions	
Height	1000 mm
Width	800 mm
Diameter	1000 mm

Steam boiler

The steam boiler (Model-TCEW-015) was used for the purpose of steam generation. Table 1 shows the specifications of boilers such as its maximum rated heat output, thermal efficiency, fuel consumption, dry weight as well as its height, width and diameter. Figure 2 shows setup of steam boiler and softener.

Steam jacketed khoa pan

Steam jacketed khoa pan made of stainless steel was installed at dairy and food processing pilot plant, CAE, Madakaisra. The khoa pan was semi-mechanically mixed with manual stirrer arrangement to scrap the sides of pan during khoa preparation. It has steam inlet, condensate outlet and pressure relief valve for releasing excess steam during the operation. It also has a pressure gauge which indicates the pressure during the operation. Uniform pressure of 1.5 kg/cm² should be maintained during the operation. Figure 3 shows the steam jacketed khoa pan installed in the

plant.

Determination of volume of khoa pan

The volume of khoa pan was calculated theoretically as well as experimentally.

Theoretical determination of volume of khoa pan

The volume of khoa pan was determined by considering the pan as a hemi sphere as shown in Fig. 4 and it was calculated by using eqn 1.

$$V = \frac{1}{3} \pi h^2 (3r - h) \dots\dots\dots 1$$

V = Volume of khoa pan, m³

h = depth of pan at the center, m

r = radius of the pan, m

Experimental determination of volume of khoa pan

Experimentally, the volume of khoa pan was calculated by filling the pan with water using a glass measuring jar of one liter up to the mark where it starts overflowing.

Materials

Fresh milk (cow and buffalo) was obtained from dairy farm and refined cane sugar was used for preparation



Fig. 2. Set up of Steam boiler and softener.

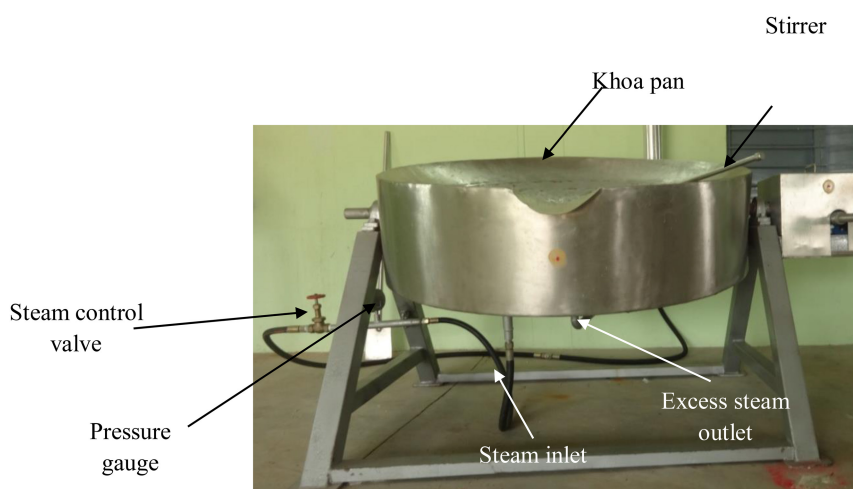


Fig. 3. Steam jacketed khoa pan installed at Dairy and Food Processing Pilot Plant, CAE, Madakasira.

of khoa Boghra and Mathur (1996).

Traditional method

For preparation of khoa traditionally, 0.925 l milk was taken and the following procedure was followed.

The initial temperature of milk was measured by Infrared thermometer.

Total soluble solids (TSS) of milk were calculated by taking five iterations through Refractometer.

When the milk starts boiling the temperature was measured for every five minutes of interval.

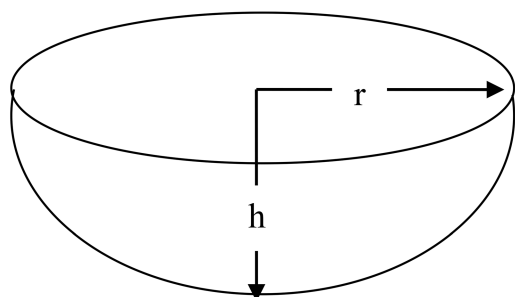


Fig. 4. Geometrical view of khoa pan.

Ten percentage of sugar was added for one liter of milk when it reached the desired consistency and a pinch of cardamom powder was added.

When the desired product was obtained the moisture content was determined by oven drying method and amount of khoa produced was recorded. Flow chart for preparation of khoa was shown in Fig. 5.

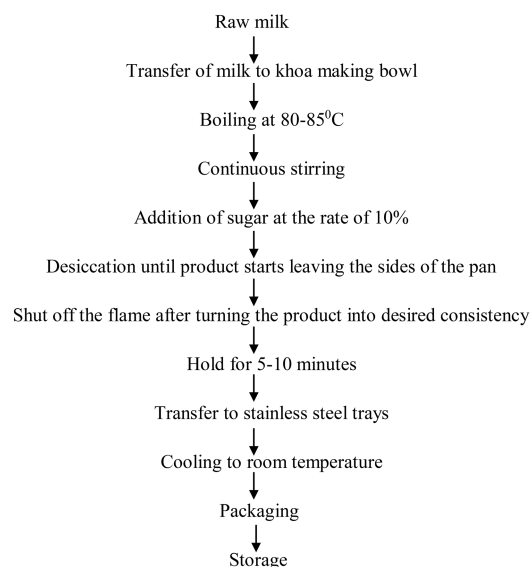


Fig. 5. Steps followed in preparation of khoa Prakash and Sharma (1984).

Preparation of Khoa in steam jacketed pan

A stainless steel double jacketed steam heated pan or evaporator was used to provide greater control of the heating process and to ensure non smoky heating. About 40 l of cow milk with 4% fat was taken and the milk was allowed to boil in the pan. During boiling, the surface of the pan was scraped and milk was stirred vigorously by a stainless steel stirrer to avoid burning of milk solids. About 1.5 kg/cm² of pressure was maintained. When the milk attained a rabri stage, heating was slowed down by reducing the pressure to 1.2 kg/cm² to prevent burning of solids on the surface, discoloration of the product, development of burnt flavor, hard body and coarse texture. The rate of stirring was increased during last stage to obtain good quality product. As soon as the product showed signs of leaving the sides of the pan, heating was stopped. It took about 1 hr 15 min to prepare a batch of khoa by this method. About 11.50 kg of khoa was obtained from 40 l of milk by adding about 4 kg of sugar.

Mass and material balance

Mass and material balance are based on law of conservation of mass. The quantities of different materials passing through processing operations can be calculated by mass and material balance equation. Any processing operation can be represented diagrammatically using process flow diagrams along with the mass and fractions of different materials flowing in and out. In general the mass and material balance can be written by (Tomislav 2013, Fig.6).

Mass in = Mass out + accumulation (Batch Process)..... (2)

= Mass out + losses (continuous process under steady state condition)

Raw Materials = Products + water vapor + stored material (3)

The steps followed in material balance in food en-

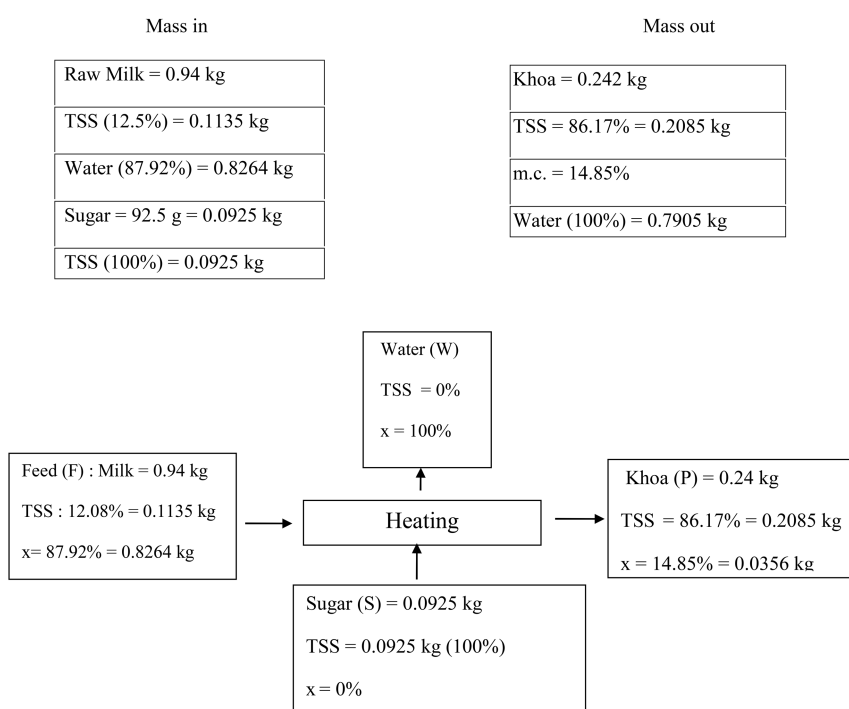


Fig. 6. Flow Sheet for Mass and Material Balance for traditional method.

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Make the process flow diagram with flow streams, mass and composition.

Select a basis (1 kg, 10 kg, 100 kg).

Make overall mass balance around a process or set of process.

Make the component or material balance for single or set of process.

Check the calculation.

RESULTS AND DISCUSSION

Volume of steam jacketed khoa pan

The volume of khoa pan was determined experimentally as well as theoretically. Experimentally it was found that khoa pan can accommodate liquid feed up to 126 l whereas theoretically its volume came out to be 130.25 l. The experimental decrease in volume

may be due to presence of chute outlet discharging the khoa. Because of the presence of this chute outlet, the pan was not filled up to its full volume.

Mass and material balance

Traditional method

In this method from 0.94 kg of milk 0.242 kg of khoa was obtained and 0.7905 kg of water was evaporated. TSS in khoa was 86.17% (0.2085kg) and about 1 hr 25 min was taken for preparation of khoa by this method. The following calculations were carried out to find out the quantity of different materials used during the process.

Mass Balance

$$\text{Feed (F)} + \text{Sugar (S)} = \text{Product (P)} + \text{Water (W)}$$

$$0.94 + 0.0925 = 0.242 + \text{water (W)} \quad \text{---- (i)}$$

$$\text{Water evaporated} = 0.7905 \text{ kg}$$

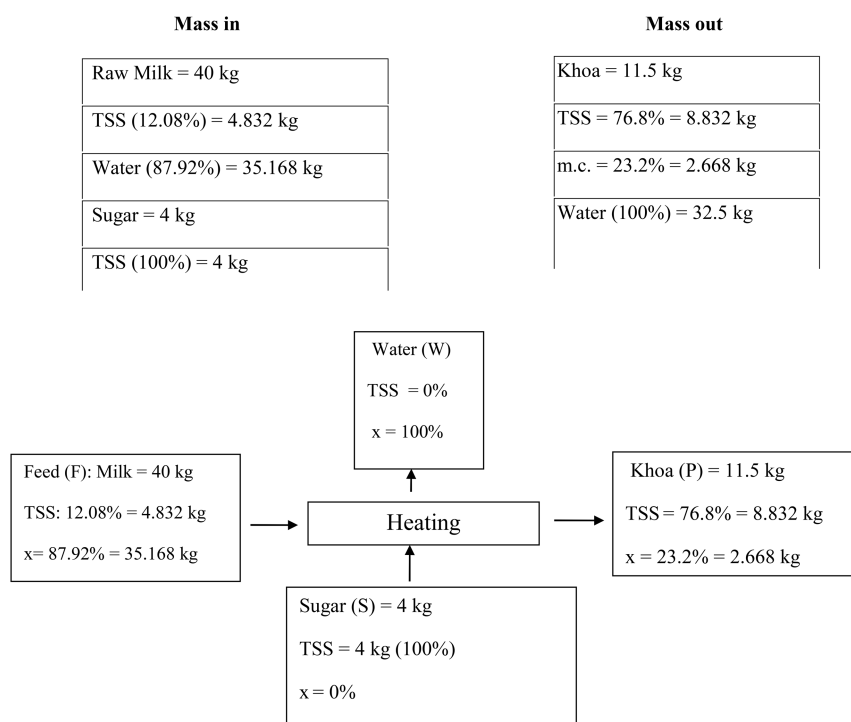


Fig. 7. Flow Sheet for Mass and Material Balance in mechanical method.

Material Balance**Moisture Balance (x)**

$$F_{x_1} + S_{x_2} = P_{x_3} + W_{x_4}$$

$$(0.94 \times 87.92) + 0 = (0.242 \times X_3) + (0.7905 \times 100)$$

$$X_3 = 14.85\%$$

Solid Balance (s)

$$F_{s_1} + S_{s_2} = P_{s_3} + W_{s_4}$$

$$(0.94 \times 12.08) + (0.0925 \times 100) = (0.242 \times S_3) + 0$$

$$11.35 + 9.25 = 0.242 S_3$$

$$S_3 = 86.17\%$$

Mechanical method

In this method from 40 kg of milk 11.5 kg of khoa was obtained and 32.5 kg of water was evaporated. TSS in Khoa was 76.8% (0.2085 kg). About 1 hr 15 min was taken to prepare the khoa by this method. The calculations for mass and material balance are given below (Fig.7).

Mass Balance

$$\text{Feed (F) + Sugar (S) = Product (P) + Water (W)}$$

$$40 + 4 = 11.5 + \text{water (W)} \quad \text{---- (i)}$$

$$\text{Water evaporated} = 32.5 \text{ kg}$$

Material Balance**Moisture Balance (x)**

$$F_{x_1} + S_{x_2} = P_{x_3} + W_{x_4}$$

$$(40 \times 87.92) + 0 = (11.5 \times X_3) + (32.5 \times 100)$$

$$X_3 = 23.2\%$$

Solid Balance (s)

$$F_{s_1} + S_{s_2} = P_{s_3} + W_{s_4}$$

$$(40 \times 12.08) + (4 \times 100) = (11.5 \times S_3) + 0$$

$$S_3 = 76.8\%$$

CONCLUSION

Khoa occupies an important place among indigenous milk products. Khoa has considerable economic, dietary and commercial significance to the Indian population. It forms an important base for preparation of variety of milk sweets which are an integral part of the Indian food heritage. It has been observed that practically the volume accounts for 126 L whereas when calculated by theoretical method it accounts for 130.25 L. From the mass and material balances it was observed that for the conversion of raw milk (0.94 kg) with the addition of 0.0925 kg of sugar to Khoa (0.242 kg) by traditional method took about 1hr 25 minutes and Khoa prepared in open pan evaporator takes 1 hr 15 min and 11.50 kg of khoa was obtained from 40 l of milk. In this mechanical method, the khoa was prepared in less time as well as it has good appearance, flavor, texture, compared to khoa prepared by traditional method.

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