



## Effect of Operational Parameters on Sensory Attributes of Khoa Produced By Mechanized Production System

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### ABSTRACT

India is the largest milk producer nation in the world. A large part of milk produced in India has been utilized for the production of a wide variety of Traditional Indian Dairy products (TIDP). Khoa is an essential indigenous milk product used as a base material for a variety of sweets like burfi, peda, milk cake, gulabjamun, kalakand, kunda etc. With a view to mechanize the process of making viscous dairy products, Multipurpose Conical Process Vat has been developed at the Dairy Engineering Division of National Dairy Research Institute, Karnal. In the present Investigation, a systematic attempt has been made to mechanize the process of khoa production with desirable sensory attributes using Conical Process vat. Three levels of concentrated milk (i.e.  $20 \pm 1.0\%$ ,  $25 \pm 1.0\%$ , and  $30 \pm 1.0\%$  TS) along with three different steam pressures (i.e.  $1 \text{ kg/cm}^2$ ,  $1.5 \text{ kg/cm}^2$  and  $2 \text{ kg/cm}^2$ ) have been used for investigation. The product obtained was subjected to sensory evaluation using a panel of judges. Texture profile analysis was done by using a texture analyzer. Based on the overall acceptability of the product including all sensory attributes, it was found that Khoa produced by using  $1.5 \text{ kg/cm}^2$  steam pressure with  $30 \pm 1.0\%$  initial concentration of milk has desirable textural characteristics.

**Key Words:** Mechanization of khoa production, Quality of khoa, Optimization of processing parameters, Mechanization of Traditional Indian Dairy Products

### 1.INTRODUCTION

Indian Dairy Industry has undergone a sea change during the last 50-60 years and comes out to be 'The Oyster' of the global dairy industry. From a milk deficient country in the early 1960s, India has emerged today as the largest milk producer in the world. It offers a large number of opportunities to entrepreneurs worldwide, who want to capitalize on one of the world's biggest and fastest growing markets for milk and milk products. The growing demand for milk and milk products is going to present greater and newer challenges to the Indian dairy sector.

Since ancient times, traditional Indian dairy products have become inherent part of our life, festival and ceremonies. The total output of traditional milk products is estimated to be \$12 billion i.e. more than half of the total market (\$22 billion) of milk and milk products in India. The indigenous dairy products present an enormous opportunity for the organized dairy sector to modernize and scale up their production in the country. Their production and marketing can bring about significant value addition to the extent of 200%, as compared to only 50% brought by western products. The consumption of indigenous milk products is likely to grow at an annual growth rate of more than 20%. Thus, to expand business prospects, the organized dairy sector triggers a thorough face-lift of these products.

Usually, khoa is prepared by continuous boiling of milk in an open kettle until desired concentration (normally 65-72% total solids) and texture are obtained. It has been estimated that about 5.5% of total milk production is converted into Khoa (Banerjee, 1997) and based on present milk production of about 100 million tonnes per annum, the amount is equivalent to 15.17 million kilograms of Khoa per day.

About 15 plants in India have initiated in-line production of Khoa with daily output of 1 to 4 tonnes. There are large numbers of Khoa based sweets. These sweets are also gaining wide acceptance in African and European countries.

Khoa is the basic ingredient in most milk based sweets. Since there is scanty knowledge of basic research data about the texture of the Khoa at different stages of processing as well as at different stages of concentration of milk, it has been difficult to mechanize the process of Khoa production with desirable texture.

Hence, the present dissertation work is envisaged to produce a better sensory and rheological quality of Khoa using Conical Process Vat having engineering interventions. The operating parameters for the formation of the desired texture of the product would be investigated and optimized. Thus, the present investigation has been formulated with the objective of Study the Effect of Engineering Interventions (Operating Parameters) on sensory attributes of Khoa produced by the mechanized production system.

Khoa refers to the milk product obtained by partial dehydration of milk by heating under controlled conditions. According to PFA Rules revised in 2002, Khoa is a product obtained from cow or buffalo (or goat or sheep) milk, or a combination thereof, by rapid drying. The milk fat content should

not be less than 30% of the finished product. During the process of Khoa production from milk, heat coagulation of milk proteins, especially the whey proteins occur and the characteristics of cooked flavour appear.

Only fresh, clean milk free from colostrums and fit in every way for human consumption shall be used. It shall be free from preservatives, adulterants and any foreign matter. The fat content of the milk shall be such that the khoa conforms to the requirements given in Table 1.

**Table 1 Requirements for Khoa**

SL. NO.	CHARACTERISTIC	REQUIREMENTS FOR TYPE		
		PINDI	DANEDAR	DHAP
1.	Total solids, percent by mass, Min.	65	60	55
2.	Fat, per cent by mass, (on dry basis ), Min.	37	37	37
3.	Total ash, per cent by mass (on dry basis), Max.	6.0	6.0	6.0
4.	Titration acidity (as %LA), per cent by mass, Max.	0.8	0.9	0.6
5.	Coliform count, per gram, Max.	90	90	90
6.	Yeast and mould count per gram, Max.	50	50	50

## 2.0 MATERIALS AND METHODS

### 2.1 Experimental set-up and Accessories

The experimental setup for the proposed study consisted of multipurpose conical process vat complete in all respect with product scrapping, re-circulation, mixing & blending and improvised discharge mechanism integrated to it. The equipment as installed in the equipment testing laboratory of Dairy Engineering Division has provision for separate steam connection, condensate outlet and air vent for three steam jacket segments of the vat (Figure 1).

An electronic digital balance with a precision of 0.1 mg was used for the determination of the moisture content of samples. An electrically operated hot air oven with a range of 80°C – 120°C has been used. Apart from those sample containers; refractometer (0-50° Brix), trays, cans and SS pale etc. accessories were employed during the conduct of trials.



Figure 1 Multipurpose Conical Process Vat

### 2.2 Variable Parameters

Fresh buffalo milk of  $6.4 \pm 0.5$  % fat and  $8.9 \pm 0.2$  % SNF was procured for the experiments. In the present investigation, the effect of steam pressure on sensory characteristics of the Khoa was evaluated by maintaining three different steam pressures i.e.  $1.0 \text{ kg/cm}^2$ ,  $1.5 \text{ kg/cm}^2$  and  $2.0 \text{ kg/cm}^2$  in all the jacket segments of the Conical Process Vat. Three different initial concentrations of milk i.e.  $20 \pm 1.0\%$ ,  $25 \pm 1.0\%$ , and  $30 \pm 1.0$  % TS were selected for processing it into Khoa by using Conical Process Vat.

### 3.0 Methodology

In present study the standardized buffalo milk was procured and some preliminary platform tests were performed to ensure the raw milk quality suitable for the khoa production. Milk was concentrated at different level of concentration followed by the processing under different operation parameters as shown in Figure 2.

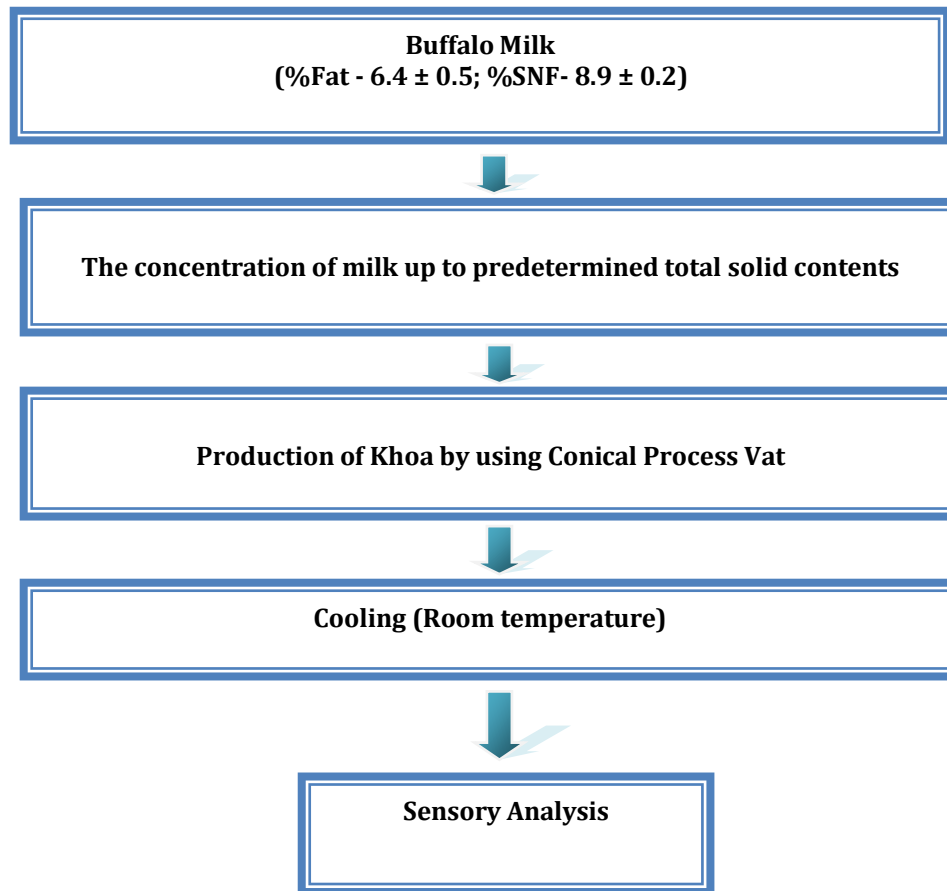


Figure 2. Process flow chart for the production of khoa

#### 3.1 Measurement and Analysis

The total solids content of milk was determined by the standard gravimetric method described in the IS: 1979 (Part-II) - 1961. The fat content in milk was determined by the Gerber method described in IS: 1224-1958. Titratable acidity was determined using the method described in IS: 1979 (Part-I)-1960.

The Khoa manufactured using Conical Process Vat by selected process variables under consideration was analyzed for Moisture / TS content. The moisture content of the product was determined by the gravimetric method as per IS: 2785 (1964).

#### 3.2 Sensory Evaluation

The *Khoa* made from fresh standardized buffalo milk has typical sensory attributes, which depends on the process variables under study, viz., steam pressure, initial concentration of milk. The *Khoa* samples were subjected for sensory evaluation by a panel of 5-7 judges selected from the Dairy Technology and Dairy Engineering Division. A 100 point descriptive scale was used for sensory attributes like Flavour, Body & Texture and Colour & Appearance.

#### 3.3 Statistical Analysis

Significance between textural and sensory characteristics as affected by different combinations of initial concentration of milk and steam pressure was tested by employing analysis of variance (ANOVA) and comparison between means was made by critical difference (CD) value.

## 4.0 RESULTS AND DISCUSSION

In the present Investigation, a systematic attempt has been made to mechanize the process of *Khoa* production with desirable sensory and texture using Conical Process vat. The preconditioning of the milk at three levels of concentration along with three different steam pressures has been adopted in the present research work. The product obtained was subjected to sensory evaluation using a panel of judges. Based on these determinations, the operating parameter for the formation of desired product quality has been optimized. The combinations of different steam pressure and initial concentration of milk used to produce *Khoa* in Conical Process vat have been coded as shown in Table 1.

**Table 1: Combination Codes used in Experimentation**

COMBINATION CODE	Steam Pressure (kg/cm <sup>2</sup> )	Concentration of Milk (% TS)
A <sub>1</sub>	1	20 ± 1.0
A <sub>2</sub>	1	25 ± 1.0
A <sub>3</sub>	1	30 ± 1.0
B <sub>1</sub>	1.5	20 ± 1.0
B <sub>2</sub>	1.5	25 ± 1.0
B <sub>3</sub>	1.5	30 ± 1.0
C <sub>1</sub>	2	20 ± 1.0
C <sub>2</sub>	2	25 ± 1.0
C <sub>3</sub>	2	30 ± 1.0

### 4.1 Studies on Sensory Characteristics of *Khoa* in relation to Steam Pressure and Concentration of Milk

Sensory quality plays a key role in determining the acceptance of the product. In the present investigation, the sensory characteristics of *khoa* were judged by 100 marks score card which includes flavor (50), body and texture (35), colour and appearance (15) and overall acceptability. To check the suitability of the results, the data obtained were subjected to evaluation through analysis of variance (ANOVA).

#### 4.1.1. Effect on Flavour of *Khoa*

Flavour is an important criterion for deciding the quality of *khoa*, which determines its acceptability. The assessment of flavour as affected by steam pressure and initial concentration of milk is as shown in Figure 2 and Table 2. The average flavour score of the *Khoa* ranged from 35 to 46.

**Table 2 Effect of Milk Concentration and Steam Pressure on the Flavour of *Khoa***

The concentration of Milk (%TS)	Steam Pressure (kg/cm <sup>2</sup> )		
	1	1.5	2
20	35 <sup>bd</sup>	42 <sup>ad</sup>	40 <sup>ad</sup>
25	40 <sup>bc</sup>	45 <sup>ac</sup>	41 <sup>bd</sup>
30	40 <sup>bc</sup>	46 <sup>ac</sup>	45 <sup>ac</sup>

Average of three replicates

\* Significant (p<0.05)

<sup>ab</sup> means with different superscripts between each row differ significantly (p<0.05)

<sup>cd</sup> means with different superscripts within each column differ significantly (p<0.05)

The analysis of variance indicates that there was a significant difference in the flavour score of the *khoa* between different initial concentrations of milk and within variable steam pressures used for the preparation of *Khoa*. F-ratio between initial concentrations of milk and within different steam pressure was found out to be 19.0 (p<0.05) and 11.615 (p<0.05) respectively. Figure 2, reveals that the flavor score of the product was significantly increased as the initial concentration of the milk was increased with an increase in steam pressure. The highest flavour score was recorded for the product at combination code B<sub>3</sub> (Table 1) i.e. at 30 ± 1.0 % TS of milk and 1.5 kg/cm<sup>2</sup> steam pressure.

#### 4.1.2 Effect on Body and Texture of *Khoa*

The body and texture score varied from 28 to 33. The minimum score was obtained for the combination code A<sub>1</sub> and B<sub>1</sub> while the maximum score was obtained for the combination code B<sub>3</sub> and C<sub>2</sub> (Table 1).

Analysis of variance interpreted that there was no significant difference (p<0.05) in the average score of body and texture of the product at different combinations of steam pressure and initial concentration of milk used. Figure 2 revealed that the body and texture scores were increased when the initial concentration of milk increased with an increase in steam pressure from 1 to 1.5 kg/cm<sup>2</sup>. Beyond this, the body and texture score was severely affected by the concentration of milk.

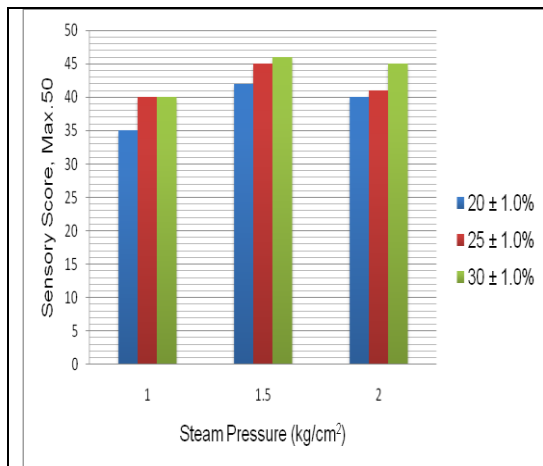


Figure 2 Flavour of Khoa as affected by steam pressure and initial concentration of milk

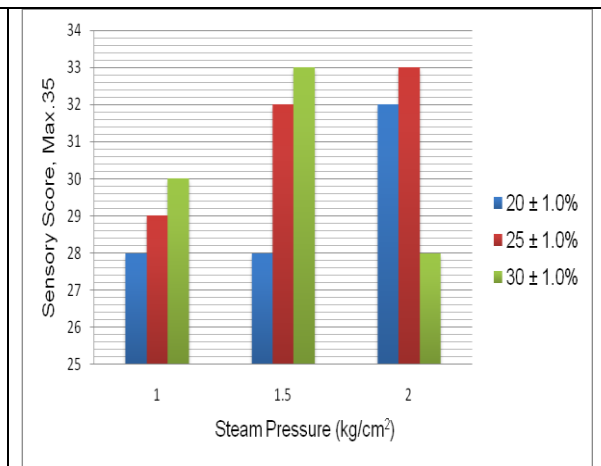


Figure 3 Body and Texture of Khoa as affected by steam pressure and initial concentration of milk

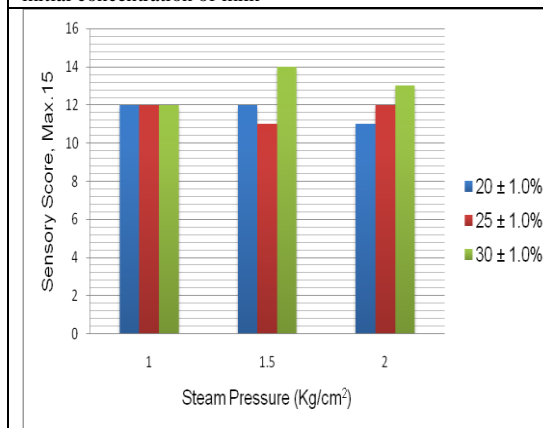


Figure 4 Colour and Appearance of Khoa as affected by steam pressure and initial concentration of milk

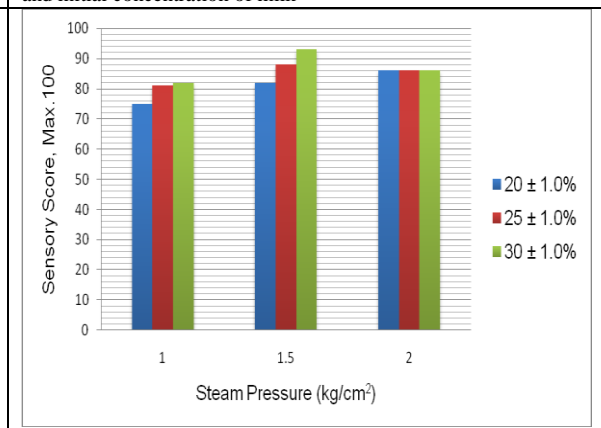


Figure 5 Overall Acceptability of Khoa as affected by steam pressure and initial concentration of milk

#### 4.1.3 Effect on Colour and Appearance of Khoa

Analysis of variance revealed that there was no significant difference ( $p < 0.05$ ) in the average score of colour and appearance of the product at different combinations of steam pressure and initial concentration of milk used. Figure 4 indicates that the colour and appearance score of the *Khoa* was almost similar for all the combination code B<sub>3</sub> (Table 1)

#### 4.1.4 Effect on Overall Acceptability of Khoa

The overall acceptability score of the experimental product varied from 75 to 93 (Table 3). The minimum score was obtained for combination code A<sub>1</sub> while the maximum score was obtained for the combination code B<sub>2</sub> (Table 1).

**Table 3 Effect of initial concentration of milk and steam pressure on overall acceptability of Khoa**

Concentration of Milk (%TS)	Steam Pressure (kg/cm <sup>2</sup> )		
	1	1.5	2
20	75 <sup>a</sup>	82 <sup>b</sup>	86 <sup>a</sup>
25	81 <sup>a</sup>	88 <sup>a</sup>	86 <sup>a</sup>
30	82 <sup>a</sup>	93 <sup>a</sup>	86 <sup>a</sup>

Average of three replicates

\* Significant ( $p < 0.05$ )

<sup>ab</sup> means with different superscripts within each column differ significantly ( $p < 0.05$ )

It is evident from the analysis of variance that there was a significant difference in the overall acceptability of the product within different steam pressure used along with the different initial concentrations of milk. F-ratio was found out to be 7.00 ( $p < 0.05$ ) with CD<sub>(0.05)</sub> value. From figure 4.11, it is clear that the overall acceptability of the product was significantly increased as the initial concentration of the milk was increased with an increase in steam pressure.

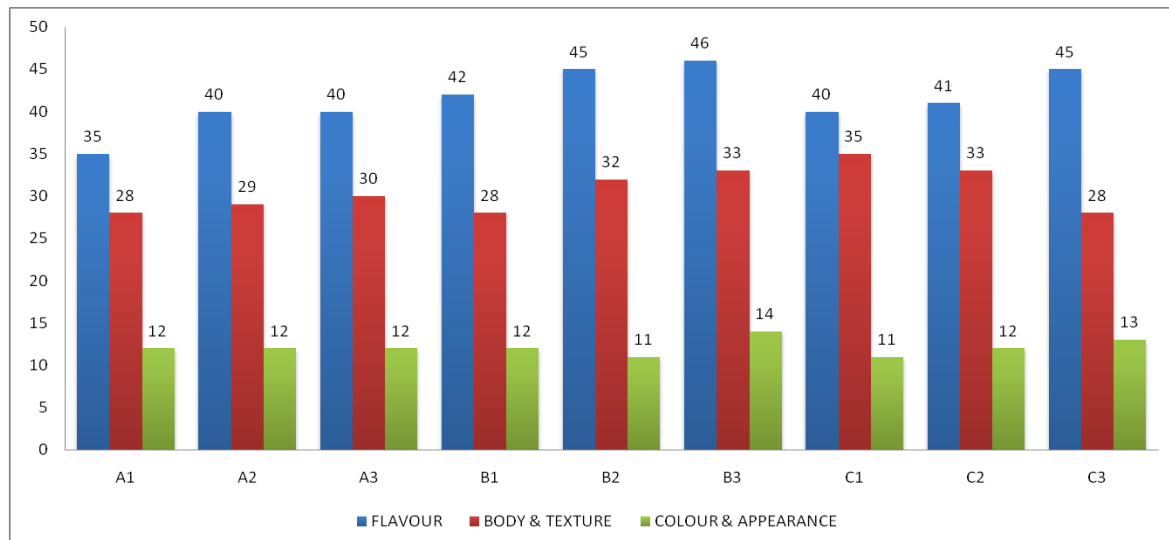


Figure 6 Average Sensory Score allotted to different Combination Codes

#### 4.2 Optimal Selection of Operating Parameter Combination for the Production of *Khoa* having desirable Sensory Attributes

The optimal combination of operating parameters for the production of *Khoa* with desirable textural attributes has been selected based on the overall acceptability of the product including all the sensory attributes of *Khoa*. Figure 6 represents the average Sensory Score allotted to different Combination Codes (Table 1). It was found that the *Khoa* produced by using combination code B<sub>3</sub> had all desired sensory attributes. Hence in the present investigation, the instrumental textural characteristics of the product made by using conical process vat at 1.5 kg/cm<sup>2</sup> steam pressure with 30 ± 1.0% initial concentration of milk, has been selected as optimal operating parameter combination.

## 5.0 SUMMARY AND CONCLUSION

*Khoa* is mainly prepared by the unorganized dairy sector using traditional processing equipment and techniques. Conventionally it is prepared by continuous boiling of milk in an open kettle until desired concentration (normally 65-72% total solids) and texture are achieved. Conventional production technology had its inherent disadvantages like poor handling of milk, unhygienic production environment, batch to batch variation, poor microbiological quality of the product, etc. With a view to mechanize the process of making viscous dairy products, Multipurpose Conical Process Vat has been developed.

Hence the present research work is envisaged to produce a better sensory quality of *Khoa* using Conical Process Vat with optimization of processing parameters. In the present investigation, the preconditioning of the milk at three levels of concentration (i.e. 20±1 %, 25±1%, and 30 ±1 % TS) along with three different steam pressures (i.e. 1.0 kg/cm<sup>2</sup>, 1.5 kg/cm<sup>2</sup> and 2 kg/cm<sup>2</sup>) has been adopted. The product obtained was subjected to sensory evaluation using a panel of judges.

It was concluded that, Based on the overall acceptability of the product including all sensory attributes, *Khoa* produced by using combination code B<sub>3</sub> (i.e. at 1.5 kg/cm<sup>2</sup> steam pressure with 30 ± 1.0% initial concentration of milk) has desirable textural characteristics. The hardness, adhesiveness, springiness, cohesiveness, gumminess, and chewiness values of *Khoa* made by using all combination codes varied from 16.657 to 27.141 N; -0.166 to -1.039 N.s; 0.069 to 0.138 mm; 0.137 to 0.210; 4.113 to 1.856 N; 0.131 to 0.547 N.mm respectively.

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