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Development and Evaluation of Mechanism for Continuous Production of Uniform Geometry of Khoa

Arshdeep Singh Sidhu[1], Amandeep Sharma[2]
[1,2]*Dairy Engineering, College of Dairy Science & Technology,*
Guru Angad Dev Veterinary & Animal Sciences University (GADVASU), Ludhiana (Punjab) India-141 004.

Abstract- About 7 % of milk produced in India is converted to khoa. It is one of the leading dairy product consumed in India as compared to cheese and butter. The manufacture of khoais largely in the hand of private sector (halwais), thatuses primitive techniques essentially based on their experience. The work on continuous khoamaking machine gained momentum in recent years as a result of greater emphasis laid for the manufacture of indigenous milk products in the organized sector. Since, number of studies has been carried out for mechanization of khoabut till date no standard packing of khoais available like some other dairy products for example paneer, dahi etc. To overcome these drawbacks study was purposed and the market samples were analyzed for geometrical variation to provide basis for the development and fabrication of experimental set up. Mechanism was developed for feeding, conveying and cutting the product into desired shape. The mechanism was powered by two motor drives. Cutting the product into uniform geometry was achieved by pneumatic pressure.The throughput capacity of the experimental setup was 15 kg per hour. The khoasamples prepared under different combinations of process parameters were subjected to physical analysis. The average weight of the product sample was 15.15±0.28 to 16.65±0.25 gram. The average length of the product sample was 45.53±1.50 to 47.13±0.53 mm. The average width of the product sample was 35.31±0.31 to 36.78±0.30 mm. The average height of the product sample was 9.61±0.46 to 10.43±0.39 mm.
Keywords:khoa, product analysis, geometry, throughput capacity

I. INTRODUCTION

India continues to be the largest producer of milk in world with 155.1 million tons in the year 2016-17 (Anon 2017). It has also been reported that from the total milk production, 50% milk produced is converted to traditional Indian dairy products (Prasad et al 2015). These products are used mainly for consumption and distribution during various occasions and festivals as greetings.

Khoa, a heat desiccated traditional Indian milk product prepared by heat concentration of milk in an open pan with continuous stirring and scrapping, is a major intermediate base for a variety of sweets like burfi, peda, kalakand,gulabjamunetc. (Acharya and Sapkota 2008). About 7% of milk produced in India is converted to khoawhich is one of the leading dairy products consumed in India as compared to cheese and butter. Khoa production is largely in the hands of private sector (halwais), that uses highly primitive techniques essentially based on their experience, which inherently suffer from many disadvantages, such as unsanitary operations, non-uniform product quality, poor handling conditions etc. (Choudharyet al 2015)

The work on continuous khoa making machine gained momentum as a result of greater emphasis laid for the manufacture of indigenous milk products in the organized sector. Since there is scanty knowledge of basic research data pertaining to the texture of the khoa, hence it is difficult to ameliorate the mechanized process of khoa production with desirable texture. The three stage SSHE developed for the manufacture of khoa was attempted for the mechanized manufacture of danedarkhoa. Number of studies has been carried out for mechanized production of pedamass.(Singh et al 2015) The work on mechanization of milk and other agricultural commodities were also reported by Sharma A and Ghuman B S (2007), Sharma et al (2016) and TalwarG and Kaur S (2017)

Presently, no standard packaging of khoa is available in the market like some other dairy productssuch as cheese, paneer, dahi etc. Khoa and khoaproducts are being sold in market in loose packing like cardboard boxes leading to loss of moisture and deteriorating its texture.Khoa is an ingredient for number of other dairy products, hence availability of khoa in standard packing will help the producer to save time and money.

II. MATERIALS AND METHODS

2.1 Experimental Set-Up

The development and evaluation of the mechanism was performed at experimental dairy plant, GADVASU, Ludhiana. The experimental set-Up mainly consists of following portions:

1. Development and fabrication of experimental set-up
2. Analysis of final product

3. Performance analysis of mechanism

To develop a mechanism the concept was developed to have sub-assemblies such as hopper for feeding and conveying, a die for shaping the material into desired shape, a cutting mechanism for portioning the material etc. The block diagram is shown in fig- 1

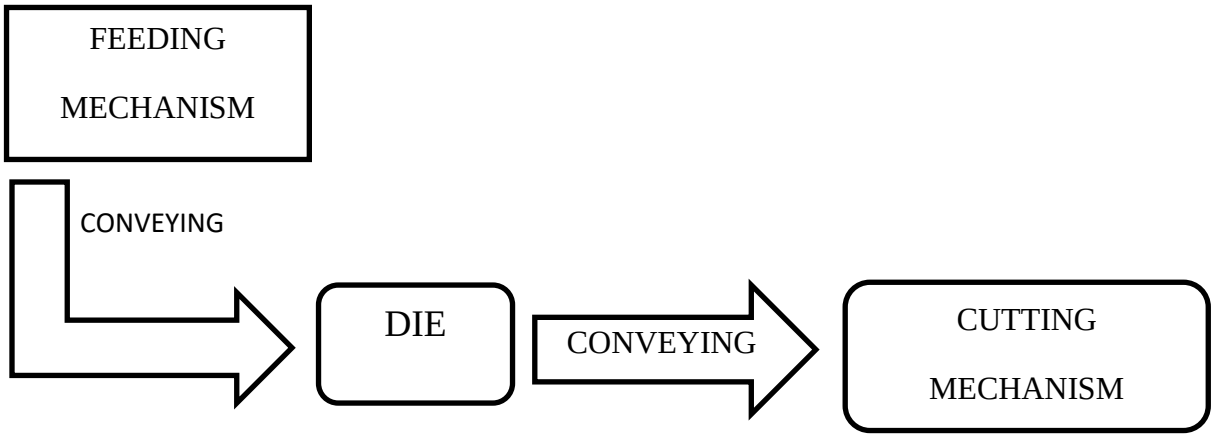

Fig- 1 Block diagram of concept model

Screw type conveying mechanism was chosen over the push mechanism which was earlier used by Singhet al2015 in the study of multi factor optimization for mechanized formation of khoapeda. The screw type conveying has advantage both conveying as well as generating the desired push/force to push the material through the die.
Concept development of the mechanismwas shown in Table – 1.

Table- 1 Concept development of the mechanism

Name of Parts	Purpose
Hopper	Feeding purpose
Screw type mechanism	Forward motion
Die	To give desired shape
Belt conveyor	For conveying product
Cutting mechanism	To cut product in desired dimension
Control panel	To control the mechanism
Electric Motors	Power source

2.2 Screw type mechanism
The main screw type mechanism is made of aluminum body and converging come inside the extruder is also made up of polished aluminum alloy. On one end of the mechanism has a hopper to feed the khoa while on another side of converging end die is placed at to extrude the khoa in desired geometry. Screw type mechanism was coupled with the 3 phase motor via belt and pulley arrangement to give it power.

2.3 Cutting mechanism
Cutting device was a rectangular blade made from stainless steel sheet of 2 mm thickness which was sharpened at circumference by grinding. Cutting blade was attached at 400 mm distance from the die to let the product to settle and fine cutting could be achieved. Blade was attached to the pneumatic pressure along with pneumatic press cylinder. Pneumatic pressure was attached to the time mechanism which works with the variable time interval, thus desired cut could be obtained by adjusting the time control.Whole cutting assembly was attached on the conveyor belt with support frame. The minimum cut that could be achieved for variable length of product was at the interval of 1 sec and maximum could be in minutes.

2.4 Conveying Mechanism

a) Conveyor belt:Conveyor belt was made using PVC green food grade belt attached upon a platform join with two rollers with run with the help of motor attached to it.

b) Rollers: Two rollers of diameter 60 mm were attached at the both ends of conveyor belt to move the belt conveyor powered by a 3 phase motor attached to the conveyor through a direct coupling.

2.5 Experimental accessories:

a) Power Drive:Two 3 phase motors were attached to mechanism to run the screw mechanism and conveyor. The motor attached to the screw has following specifications:

3 Phase Squirrel Cage Induction motor 0.75 KW 1385 RPM 220 V 50 HZ

The motor attached to the conveyor has following specifications:

3 Phase S M 63 B4 0.18 KW 8 RPM 240 V 50 HZ

b) Control Panel:Control panel consists of various controls of motors and pneumatic pressure with adjustable speed of cutter. Pneumatic pressure valve was also fixed in the control panel .the lights attached on front side of control panel indicate the working of various parts of mechanism

2.6 Preparation of test sample

Khoa used in the study was taken from one of the popular shop of Ludhiana city. About 1kg and 5 kg sample was taken for each trial. Khoawas kept under refrigerated condition for the approximately two hours before conducting the trials. For further study different range of temperature was achieved by deep freezing or placing test sample at ambient temperature.

2.7 Temperature

Khoa is generally formed or molded into various shapes manually at room temperature. Higher the temperature ofkhoamass lesser will be the pressure required for the formation of shapesand vice-versa. Also at the higher temperature khoamass with less moisture content could also be used for the formation of various shapes. But, at too high temperature the fat inkhoa will be in the semi molten state and may pose difficulty in molding. An optimum temperature is that at which khoacan retain its shape and also can be easily formed.

Following temperature range were chosen for performance analysis of the developed mechanism at different temperature as mentioned below:

a) Below 0° C (-8º C achieved by keeping khoa in deep freezer overnight) – Day1

b) 4º C (Achieved by keeping khoa in refrigerator) – Day2

c) 27 - 35º C (Achieved by keeping khoa at room temperature) – Day3

2.8 Die geometry

Rectangular die (10mm×40mm)was chosen as the khoa based products such as burfi are in rectangular shape available in market

2.9. Analysis Of Final Product

The khoasamples prepared under different combinations of process parameters were subjected to geometrical analysis.

2.10 Performance analysis of mechanism

2.10.1 Throughput Capacity

The different trials were conducted to measure the capacity of the mechanism in variable quantity and temperature of feeding. Three types of lots were taken in order of half kg, one kg and five kg on different days and time were noted down to measure the capacity and performance of mechanism. The trials were repeated on various days to minimize the error and temperature variation was also observed.

2.10.2 Power consumption

Tocalculate energy consumption costs, the unit wattage of different equipment's in the experimental setup was measured using Extech EX810 1000 Amp Clamp Meter with IR Thermometer (maximum input- 1000A DC/AC, Resistance-250 DC/AC, Type K temperature- 60V DC, 24V AC). The values obtained were then multiplied by the number of hours mechanism was operated and power consumption of whole day was calculated.

III. RESULTS AND DISCUSSION

The experiments were conducted at Experimental dairy plant, College of dairy science and technology, GADVASU. The schematic diagram of the experimental set up is shown in Fig– 2

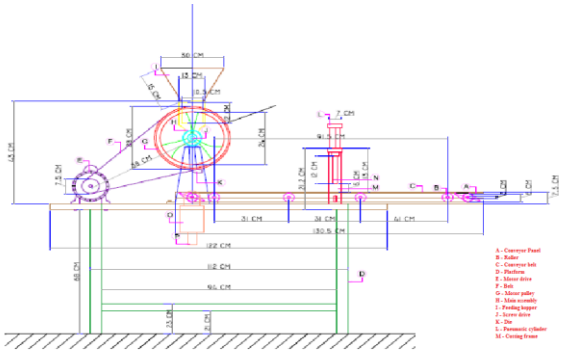

Fig- 2 Schematic diagram of the experimental set up

3.1 Product Analysis(Geometrical analysis)

Four khoasamples were collected from the each trial conducted on mechanism on different days at different temperature and were analyzedfor its geometric shape.

The value for weight of different samples lies between 15.15±0.28 to 16.65±0.25 g.Table – 2showed the significant difference in samples. On day1 and day3 the samples were non-significantly different ($p<0.05$) while on day2 the sample A was significantly different ($p<0.05$) from sample D. On observing the samples on different days it was observed that sample A, B, C and D were significantly different ($p<0.05$) on day1 and day3 while samples were non-significant different on day2 and day3.the variation was observed due to change in temperature of the khoa feed in.

Table- 2 Analysis of product samples of khoa – WEIGHT (Mean±SD) in gram

Sample	Day 1	Day 2	Day 3
A	15.15±0.28a2	15.95±0.47b1	16.28±0.43a1
B	15.33±0.22a2	16.23±0.34ab1	16.3±0.27a1
C	15.40±0.29a2	16.43±0.28ab1	16.35±0.25a1
D	15.65±0.42a2	16.65±0.25a1	16.3±0.18a1

The mean value for length was 45.53±1.50 to 47.13±0.53 mm.In table – 3 the average length of different samples from each trails were taken and variation was observed among the samples and on different days at various range of temperature but no significant difference ($p<0.05$) was observed among the samples neither on the temperature basis.

Table – 3Analysis of product samples of khoa – Length (Mean±SD) in mm

Sample	Day 1	Day 2	Day 3
A	46.34±0.32a1	46.61±1.03a1	47.13±0.53a1
B	45.53±1.50a1	46.53±0.35a1	46.44±0.39a1
C	46.20±0.15a1	46.26±0.15a1	46.37±0.36a1
D	46.51±0.38a1	46.40±0.33a1	46.33±0.29a1

The mean value for width was 35.44±0.38 to 37.07±0.12 mm.The table – 4 shows the average value of width of different samples taken in four different trials on three different days. On day1 the difference among the samples were non-significant ($p<0.05$). On day2 sample A was significantly different ($p<0.05$) from sample B, C and D and sample B, C and D were non-significant different ($p<0.05$) among each other. On day3 sample A was significantly different ($p<0.05$) from sample D. On observing the each sample on different days and at different temperature it was observed that sample B, C and D were significantly different ($p<0.05$) on day1 and day3. The variation in the samples were observed due to variation in temperature as at higher temperature product settle down at the conveyor belt and become more sticky comparable to low temperature.

Table – 4Analysis of product samples of khoa – Width (Mean±SD) in mm

Sample	Day 1	Day 2	Day 3
A	35.31±0.31a2	35.19±0.94b2	36.78±0.30ab1
B	35.31±0.32a2	36.57±0.41a1	36.95±0.23ab1
C	35.64±0.47a2	36.71±0.24a1	37.07±0.12a1
D	35.44±0.38a2	36.36±0.38a1	36.55±0.33b1

The mean value for height was 9.61±0.46 to 10.43±0.39 mm.The table- 5 compares the average height of different samples at different temperature. On observing it was noticed that the samples were non-significantly different ($p<0.05$) on day1 and day2 while on day3 at ambient temperature sample A were significantly different ($p<0.05$) from sample B and C. On observing the variation among each sample, the sample A and B were significantly different ($p<0.05$) on day1 and day2. The variation was due to difference in temperature as this lead to change in texture of the product.

Table – 5Analysis of product samples of khoa – Height (Mean±SD) in mm

Sample	Day 1	Day 2	Day 3
A	9.98±0.39a12	9.61±0.46a2	10.43±0.39a1
B	10.15±0.13a1	9.63±0.40a2	9.86±0.22b12
C	10.05±0.24a1	10.01±0.17a1	9.69±0.40b1
D	10.01±0.18a1	9.90±0.17a1	9.98±0.16ab1

3.2 Performance analysis of mechanism

For calculating the throughput capacity of the experimental set-up the mechanism was first run by taking the test sample of dough as it had same texture and body of fresh khoa. Later the khoawas taken from local market and different trials were taken to calculate the capacity of mechanism. The trials were also repeated at various temperature ranges to study the effect of temperature on mechanism performance. So considering the different trials on various temperature and days, the capacity of mechanism was estimated to be about 15 kg per hour.

Two 3 phase motors were attached to the experimental setup which runs the screw type mechanism and the belt conveyor. The power consumed by motor 1 and motor 2was 0.75 kW and 0.18 kW on hourly basis.

IV. CONCLUSION

The production of khoais still a batch process, since its demand has been rise in whole country and even in the foreign countries to manufacture other dairy products. There was need to develop a mechanism for continuous production of khoa to pack in standard packing. The mechanism developed produce the continuous production of uniform geometry of khoa. The throughput capacity of the experimental setup was 15 kg per hour. The khoasamples prepared under different combinations of process parameters were subjected to physical analysis. The average weight of the product sample was 15.15±0.28 to 16.65±0.25 gram. The average length of the product sample was 45.53±1.50 to 47.13±0.53 mm. The average width of the product sample was 35.31±0.31 to 36.78±0.30 mm. The average height of the product sample was 9.61±0.46 to 10.43±0.39 mm. It was found that material of conveyor belt need to be improved as product got stick on high temperature.

V. REFERENCES

[1] Acharya P. P, Agrawal J,"Effect of packaging materials and modified atmosphere packaging on the shelf-life of khoa",Journal of Science and Technology,11:87-94, 2010.
[2] Anonymous,"Annual report 2016-17", http://www.Indiastat.com, Cited on May 29, 2017.2017.
[3] Choudhary S, Kumari A. and Arora S,"Factors affecting heat induced changes in khoa: A Review", Indian Journal of Dairy Science,68(5):415-24, 2015.
[4] Prasad R., Tanwar B. and Dey A,"Khoa: A heat desiccated indigenous indian dairy product",Research Journal of Pharmaceutical, Biological and Chemical Sciences,6(5): 39-48,2015.
[5] Sharma A., Gupta S., and Kaur K,"Conceptual design approach of farm milk chiller"International Journal of Engineering Science and Management Research,3(2): 62-67, 2016.
[6] Sharma A., Kaur K., and Gupta S.,"Design of milk chilling system under country location", Green Farming,7(1) 1-5, 2016.
[7] Sharma A.and Ghuman B. S., " Development and Testing of Prototype for On-Farm Waxing and Grading of Fresh Kinnow Mandarin", International J of Tropical Agriculture,25(1-2): 57-63,2007.
[8] Singh G., Sawhney I. K. and Minz P. S.,"Multi factor optimization for mechanized formation of khoapeda", Indian Journal of Dairy Science ,68(5): 425-34, 2015.
[9] TalwarG.and Kaur S.,"A review on mechanization of traditional dairy products",Indian Journal of Dairy Science, 70(1): 1-102017.