RESEARCH ARTICLE

SENSORY CHARACTERISTICS OF FRESH EXTRUDED *PEDA*

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Abstract: The traditional dairy products carry value in the indian society as they are nutritious and have become the invitable part of feasts, celebrations, festivals and religious rites. *Peda* is one of the most popular khoa based traditional dairy sweets enjoyed by everyone due to its taste and health aspects.Traditionally, it is prepared by heating a mixture of *khoa* and sugar in a *karahi* (iron pan) with the help of *khunti*until the desired granular, hard texture and flavour develops. Present study was undertaken to investigate the possibilities of inducting extrusion technology for production of acceptable quality *peda*. The extruded *peda* were prepared by introducing product mixes C_0 (70% *khoa*& 30% sugar); C_1 (60% *khoa*, 05% SMP, 05% *ghee*& 30% sugar); C_2 (55% *khoa*, 10% SMP, 05% *ghee*& 30% sugar) and C_3 (50% *khoa*, 15% SMP, 05% *ghee*& 30% sugar) into the extruder system and processed at barrel temperature of 60, 70 & 80^0C and screw speed 14, 21 & 28 rpm. Among different set of treatment combinations, product mix C_2(i.e. 55% *khoa*, 10% SMP, 05% *ghee*& 30% sugar) processed at 80^0C barrel temperature and 28 rpm screw speed resulted in most acceptable extruded *peda* in terms of sensory characteristics.

Keywords: Khoa, Peda, Extruded peda, Extrusion technology

INTRODUCTION

Traditional dairy products and sweets are an integral part of Indian heritage and have great social, religious, cultural, medicinal and economic importance. It is estimated that about 50-55% of total milk produced in India is converted into variety of traditional dairy products by the traditional unorganised sector i.e. *halwais*by using various processes such as heating, heating cum acid coagulation, heat dessication and fermentation (Bandyopadhyay *et al*., 2006). It is also estimated that out of these around 7% of milk is used for manufacture of popular heat desiccated traditional dairy products. *Khoa* occupies a prominent place in traditional indian dairy products sector. Among the different traditional dairy products prepared from *khoa, peda* have high commercial significance because of their popularity throughout the country and relatively longer shelf life than other sweets (Naresh *et al.,* 2009). Traditionally, *peda* is mostly prepared by heating a mixture of *khoa* and sugar in a *karahi* (iron pan) with the help of *khunti*until the desired granular, hard texture and flavour develops. Its mechanized process invloves heating *khoa* to 60^0C and adding sugar, flavour and other ingredients in a planetary mixer. The dough after cooling to 5^0C is fed to *peda* shaping machine followed by packaging (Banerjee, 1997).

Extrusion technology has become very popular and is being increasingly used for the manufacture of various food products. In the extrusion technology, single or twin screw food extruder are used to transport, mix, knead, shear and/or cook multiple ingredients into a uniform food product by forcing the ingredient mix through die to produce specific shapes and lengths (Riaz, 2000). Extrusion is currently utilized to produce textured protein products, snack foods, toast and confectionary products. In spite of its immense potential, in the dairy industry extrusion technology is rarely utilized. Some research work has been done, on only very few products examples is casein/caseinate production (Fichtali, 1990), production of processed cheese (Zuber *et al.,* 1987; Kazuo *et al.,* 1993; Adhikari *et al.,* 2009), mozzarella cheese (Ferrari *et al.,* 2003), *sandesh* (Kumar and Das, 2007) etc. Extrusion is a very useful technology for dairy processing operations involving conveying, mixing, kneading, cooking, shearing and shaping which is yet to be exploited by the dairy industry.Considering the capability of extrusion machine, a study was undertaken to investigate the possibilities of inducting extrusion technology for production of acceptable quality extruded *peda*.

MATERIALS AND METHODS

Good quality fresh *khoa* and *ghee*were obtained from Chhattisgarh State Cooperation Dairy Federation Ltd., Urla, Raipur. Skim Milk Powder, (SAGAR,

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AmulFed Dairy, Bhat) and sugar of commercial grade were procuredfrom local market of Raipur city.

Details of product mix

The quality of any finished product depends on the properly balanced high quality raw ingredients. In this study *khoa* (75% total solid) @ 70, 60, 55 & 50% were used as base materails for making extruded *peda* in all four treatment combinations i.e. C_0, C_1, C_2& C_3 respectively. Skim milk powder (SMP) @ 0, 5, 10 & 15% were used as a source of milk solid not fat to replace amount of *khoa* in C_0, C_1, C_2& C_3 respectively. *Ghee* @ 5% were used as a source of milk fat and kept constant in combination C_1, C_2 and C_3. Cane sugar @ 30% by weight of *khoa* was added to sweeten the product in all four combinations in ground form in order to enhance degree of mixing. The details of treatment combinations used for preparation of extruded *peda* were as below:

C_0 : 70% *khoa*0% SMP, 0% *ghee*& 30% sugar (control)
C_1 : 60% *khoa*, 5% SMP, 5% *ghee*& 30% sugar
C_2: 55% *khoa*, 10% SMP, 5% *ghee*& 30% sugar
C_3: 50% *khoa*, 15% SMP, 5% *ghee*& 30% sugar

Twin screw extruder system

In the food process industry single or twin- screw extruder is commonly employed to produce range of food products due to its versatility in nature. In this study, a twin screw co-rotating extruder(Model: SY 30-IV, Jinan Saibainuo Technology Development Co. Ltd., China) was used in order to evaluate its functionality and applicability for manufacturing extruded *peda.*The complete specifications of the twin screw extruder used in the study for manufacture of extruded *peda* is presented in Table 01.

Table 1. Specifications of the TSE for production of extruded *peda*

Diameter of screw	2.6 cm
Root diameter	1.9 cm
No. of flight	33
Flight clearance	0.5 mm
Pitch	3.4 to 1.8 cm
Channel width	2.6 to 1.2 cm
Axial Flight width	4 to 2 mm
Flight depth	3 to 4 mm
Total axial length of flighted section of screw	65 cm
Helix angle	17^0
Diameter of barrel	5.7 cm
Barrel length	65 cm
Length of feeding zone	7 cm
Length of heating zone	58 cm
Diameter of mould plate die	2 cm

The extruder had four temperature control zones along the barrel where heating was performed by four induction heaters. Every heating zone also had water jacket for cooling function. The twin screw speed of extruder system was controlled by variable frequency drive (VFD) motor (3 phase, 7.5 HP) with gear box. All the parameters of the extruder were controlled through the LCD computer control system.

Processing parameters

The performance characteristics were investigated as a function of barrel temperature and screw speed. Preliminary trials have been conducted to optimize the operational parameters in which three levels of barrel temperature i.e. 60, 70 & 80^0Cand three levels of screw speed i.e. 14, 21 & 28 rpm were selected. The product mixes C_0, C_1, C_2& C_3were subjected to above process parameters to produce extruded *peda.*

Manufacture of extruded *Peda*

The process chart for manufacture of extruded *peda* is shown in Fig. 01. The extruder system was put into the operation after setting of processing parameters and stabilization of barrel temperatures. The product mix which consisted of C_0 (70% *khoa*0% SMP, 0% *ghee*& 30% sugar); C_1 (60% *khoa*, 05% SMP, 05% *ghee*& 30% sugar); C_2 (55% *khoa*, 10% SMP, 05% *ghee*& 30% sugar) and C_3 (50% *khoa*, 15% SMP, 05% *ghee*& 30% sugar) was introduced into the feeding section of twin screw co-rotating extruder. The product mixes C_0, C_1, C_2& C_3were extruded at each of the three different barrel temperatures (60, 70, 80^0C) and screw speeds (14, 21, 28 rpm). The extruder was emptied and cleaned between each run. During the extrusion processing, the product mixes was handled by the screw flight while moving and conveyed forward through a mixing/kneadingsection, evaporation/cooking section and finally extruded through the mould plate fitted at the exit. *Peda* mass was collected in a clean tray and after cooling to room temperature, it was then formed manually to round balls of about 20-25 g each. Fresh product was then subjected to sensory evaluation.

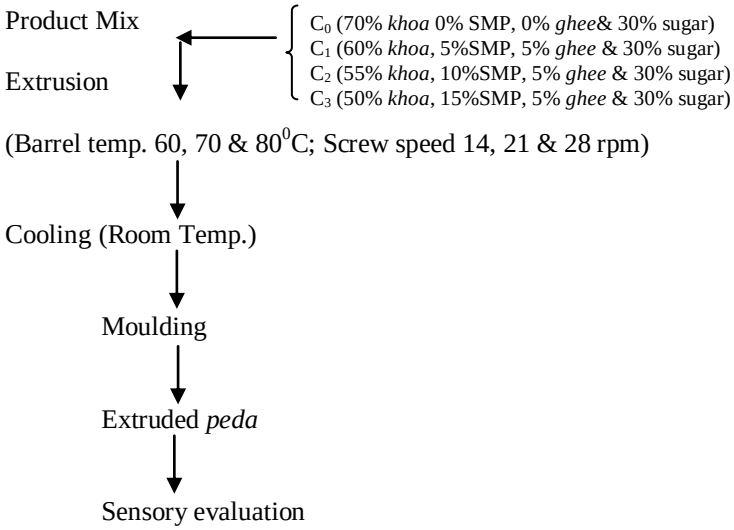

Fig.1: Process chart for manufacture of extruded *peda*

Sensory evaluation

In order to check the consumer acceptance and opinion sensory evaluation was carried out for fresh extruded *peda*samples by using 9 point Hedonic scale (ranging from 1 = disliked extremly to 9 = liked extremly) as developed by Gupta (1976). The product was made in replicates of three and served to a panel of five judges for sensory properties such as colour and appearance, flavour, sweetness, body & texture and overall acceptability.

RESULTS AND DISCUSSION

Effect of barrel temperature

Three-barrel temperature i.e. 60, 70 and 80^{0}C were selected for study. Below the barrel temperature of 70^{0}C the sensory qualities of the extruded *peda* was found to be undesirable. It was observed that during extrusion cooking of product mixes, barrel temperature of 60^{0}C resulted in under-cooked product. The lowest sensory score recorded were 7.02, 6.54, 7.06, 7.26 and 6.90 for sensory characterisics colour and appreance, body and texture, flavour, sweetness and overall acceptability respectively. It was observed from Table 2 that sensory characteristics of extruded *peda*increased significantly (P< 0.05) with increasing barrel temperature.

The sensory quality of *peda* with respect to flavour (sweet pleasant), body and texture (smooth and soft texture) and colour and apperance (slight yellow brown) was found to be good (acceptable) at barrel temperature of 80^{0}C. It was noticed that, beyond the highest selected temperature of 80^{0}C and screw speed of 28 rpm the flavour, body & texture and colour and appearance of extruded *peda* resulted in slightly nutty and cooked flavour, firm body and pronouced brown colour respectively.At very high temperature squeezing of free fat was observed which may be due to the rupturing of fat globule membrane which resulted in firm body & texture of the finished product. The results are in agreement with Boghra and Mathur (1996) where they reported that there is release of free fat due to rupturing of fat during high heat treatment processing of *khoa* and *peda*. The exit temperature of melt of the extruded *peda* mass was somewhat higher than the selected barrel temperature during the extrusion processing. This may be due to the frictional heat generated between the screw and barrel surfaces. This observation is consistent with studies done by Riaz (2000) and Guy (2001). The desirbale brown colour at a barrel temperature of 80^{0}C with screw speed of 28 rpm could be attributed to the maillard browning when the product exposed to high temperature.

Table 2. Effect of barrel temperature on sensory properties of freshextruded *peda*

Barrel temp. (^{0}C)	Sensory properties				
	Colour &Appearance	Body & Texture	Flavour	Sweetness	Overall Acceptability
60	7.02^a	6.54^a	7.06^a	7.26^a	6.90^a
70	7.17^{ab}	6.87^b	7.35^b	7.38^{ab}	7.10^b
80	7.27^b	7.15^c	7.37^b	7.40 ^{b}	7.23^b

F value	1.13	18.71	9.58	2.53	5.78
SE	0.22	3.40	1.04	0.22	1.01
CD (5%)	0.21	0.20	0.15	0.14	0.19

Effect of screw speed

In order to avoid burning of milk solids due to sticking over the inner surface of extruder barrel and uniform distribution of product mix during processing, it is required to be scraped countinously. Three screw speed i.e. 14, 21 and 28 rpm were selected for this study.

In *peda* making, the speed of screw plays an important role in deciding the quality of product in general and body and texture in particular. It was observed from Table 3 that the increased speed of screw improved the overall quality of extruded *peda*. Moreover, the body and texture score and thereby overall acceptability increased significantly ($P< 0.05$) with increasing speed of screw. Shorter residense time is desirable for better product characteristics, which are achieved at higher screw speeds. The maximum score for colour and appreance (7.30), body and texture (7.37), sweetness (7.40) and overall acceptability (7.15) were recorded for the *peda* processsedat the higher screw speed of 28 rpm while flavour (7.41) obtained at screw speed 14 rpm. Higher scew speeds promotes shorter residence time, efficient mixing and better dispersion of the product within extruder barrel. Narwade *et al.*, (2007) obtained higher sensory score for *peda* samples made traditionally at higher speed of stirrer. Similarly, Reddy (1985) also recorded higher sensory score and recommended high speed of stirrer for the manufacture of *peda*. However, the mixer/extruder screw speed influences some compositional (moisture & fat) and functional (free oil) characteristics of the product after some extent (Renda *et al.*, 1997). They reported higher screw speed causes higher fat loss which resulted in lower moisture and fat content in final finished product. This findings is also in agreements with Chennigaraju *et al.* (2005). They recorded increased hardness in recombined butter from 0.3353 kg/cm^2 at a linear screw speed of 0.14 m/s to 0.4126 kg/cm^2 at the screw speed of 0.38 m/s. The increase in hardness with the increase in screw speed may be attributed to the increase in pressure developed at the end of the screw forming system. But, in present study twin screw extruder were operated with an open end, therefore the pressure gradient along the down stream direction was small. The dominant flow were drag flow by the screw root. The selected highest screw speed i.e. 28 rpm was found to be optimum to produce acceptable quality products.

Table 3. Effect of screw speed on sensory properties of fresh extruded *peda*

Screw speed (rpm)	Sensory properties				
	Colour &Appearance	Body & Texture	Flavour	Sweetness	Overall Acceptability
14	7.05^{a}	6.83^{a}	7.41^{b}	7.21^{a}	6.95^{a}
21	7.16^{ab}	6.86^{a}	7.28^{b}	7.33^{ab}	7.13^{ab}
28	7.30^{b}	7.37^{b}	7.09^{a}	7.40^{b}	7.15^{b}
F value	0.07	0.05	8.24	0.80	2.61
SE	0.01	0.01	0.90	0.07	0.45
CD (5%)	*0.21*	*0.20*	*0.15*	*0.14*	*0.19*

Effect of product mix

Four levels of spray dried skim milk powder viz. 0, 5, 10 & 15 parts and khoa 70, 60, 55 & 50 parts were used for making extruded *peda*. In all the combinations sugar level were kept constant viz. 30 parts while ghee level were kept constant viz. 5 parts in all SMP added formulations. Extruded *peda* were prepared according to the method already described in Fig.01. Most of the judges preferred extruded *peda*samples prepared from C2 combination. The effect of the levels of ingredients on sensory quality of extruded *peda* has been shown in Table 4.

The maximum score for colour and apprearance (7.40), sweetness (7.43) and overall acceptability (7.40) were recorded for the combination C_2. The highest score for body and texture (7.17) were recorded for combination C_3 while flavour (7.44) for combination C_1. However, combination C_2 were at par with combination C_3& C_1in body & texture and flavour attributes respectively. During the experiment it was observed that combination C_0 produces dark colour and loose body which resulted in poor overall acceptability score. combination C_3 resulted in powdry taste, under cooked and hard body in finished products. It may be due to the higher

concentraion of solid not fat and lesser amount of fatty material content. This observation is consistent with studies done by Londhe (2006) and Suryawanshi *et al.*(2014).

Table 4. Effect of product mix on sensory properties of fresh extruded *peda*

Product mix	Sensory properties				
	Colour & Appearance	Body & Texture	Flavour	Sweetness	Overall Acceptability
C_0	6.95^{a}	6.54^{a}	7.20^{ab}	7.24^{a}	6.66^{a}
C_1	7.26^{bc}	6.58^{a}	7.44^{c}	7.39^{ab}	7.00^{b}
C_2	7.40^{c}	7.11^{b}	7.30^{bc}	7.43^{b}	7.40^{c}
C_3	7.13^{ab}	7.17^{b}	7.11^{a}	7.34^{ab}	7.25^{c}
F value	4.93	16.65	5.06	1.84	15.91
SE	0.99	3.02	0.55	0.16	2.78
CD (5%)	0.24	0.23	0.17	0.16	0.22

CONCLUSION

The present investigation provides information on feasibility of extrusion processing on the quality of *peda.* Based on the statistical analysis of sensory data treatment combination C_2 (i.e. 55% *khoa*, 10%SMP, 5% *ghee*& 30% sugar) processed at 80^0C barrel temperature and 28 rpm screw speed were found the best. Hence, the twin screw co-rotating extruder could be used for cooking of *khoa*, sugar, SMP mix to get the soft garde extruded *peda* with desired quality.

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