The Pharma Innovation Journal 2023; SP-12(8): 21-26

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(8): 21-26

www.thepharmajournal.com
Received: 08-06-2023
Accepted: 15-07-2023

KK Sandey
Department of Dairy Engineering, College of Dairy Science and Food Technology, Raipur, DSCVKV, Durg Chhattisgarh, India

S Karthikeyan
Department of Dairy Technology, College of Dairy Science and Food Technology, Raipur, DSCVKV, Durg, Chhattisgarh, India

Sapna Jain
Department of Dairy Technology, College of Dairy Science and Food Technology, Raipur, DSCVKV, Durg, Chhattisgarh, India

MA Qureshi
Department of Dairy Technology, College of Dairy Science and Food Technology, Raipur, DSCVKV, Durg, Chhattisgarh, India

YK Naik
Department of Dairy Technology, College of Dairy Science and Food Technology, Raipur, DSCVKV, Durg, Chhattisgarh, India

AK Agrawal
Department of Dairy Engineering, College of Dairy Science and Food Technology, Raipur, DSCVKV, Durg Chhattisgarh, India

MK Yadav
Department of Dairy Technology, College of Dairy Science and Food Technology, Raipur, DSCVKV, Durg, Chhattisgarh, India

Corresponding Author:
Sapna Jain
Department of Dairy Technology, College of Dairy Science and Food Technology, Raipur, DSCVKV, Durg, Chhattisgarh, India

Textural characteristics of extruded *peda* during storage

KK Sandey, S Karthikeyan, Sapna Jain, MA Qureshi, YK Naik, AK Agrawal and MK Yadav

Abstract
In the present investigation the textural quality of *peda* prepared by using extrusion process was evaluated and compared with control *peda* samples. The *peda* were prepared by using product mix including skim milk powder, *khoa,* ghee and sugar in different proportions. The twin screw extrusion machine was used at three different levels of barrel temperature and screw speed for preparation of extruded *peda*. Their textural profiles were evaluated. All the samples of *peda* had showed significant increase in hardness, gumminess and chewiness values at 5% level of significance during storage at 37±1 °C for 7 days. On the contrary, adhesiveness values of all *peda* samples significantly decreased. The initial values of cohesiveness and springiness had changed during storage but changes were not significant. The hardness, gumminess and chewiness were significantly ($p \leq 0.05$) increased from 1st day to 20th day. Other textural characteristics of *peda viz*. adhesiveness, cohesiveness and springiness were found to be non-significant during low temperature storage. The best quality extruded *peda* in terms of textural characteristics after control sample was produced by keeping process parameters of barrel temperature of 80 °C, screw speed of 14 rpm and feed compositions containing of 10% skim milk powder, 55% khoa, 5% ghee and 30% sugar.

Keywords: *Peda*, textural properties, hardness, cohesiveness, chewiness, adhesiveness

Introduction
Traditional Indian Dairy Products have great social, religious, cultural, nutritional contribution in our lives. In India, about 50-55% of total milk produced is converted into variety of traditional dairy products by unorganized sector esp. local vendors, *halwais*, by using conventional methods at small scale (Bandyopadhyay *et al*., 2006) [2]. Around 7% of this is used for the production of popular heat desiccated dairy products. *Khoa, Peda* holds high commercial value in comparison with other traditional dairy products, because of their popularity all through the country and fairly longer shelf life than other sweets (Naresh *et al.*, 2009) [7].

Peda is prepared by heating a mixture of *khoa* and sugar until the desired granular, hard texture and flavour development. Different varieties of *peda* have distinct sensory characteristics but the base material is *khoa* along with sugar. Preparation of *peda* from skimmed milk powder (SMP) is one of the well-known practices and also accepted in market. Suryawanshi *et al.* (2014) [16] prepared *peda* from various combinations of cow milk and skimmed milk powder. Skimmed milk powder was used up to 50%. The *peda* prepared using buffalo *khoa* powder had acceptable quality when stored up to 105 days at room temperature (Thompkinson and De, 1981) [17]. Londhe (2006) [6] prepared acceptable quality *peda* from different combinations of skim milk powder (SMP), *ghee*, water and sugar. Sandey *et al.* (2018) [12] reported the effect of product mix (*khoa* and skim milk powder in different proportions) and processing parameters of twin screw extruder on sensory quality of fresh extruded *peda.*

Texture is a vital characteristic that affects the product quality during processing and post processing handling. It influences food habits, affects shelf life and consumer acceptance for the food. Patel *et al.* (1990) [9] used Instron Universal Testing Machine to study texture of *peda*. They reported a significant correlation between certain instrumental and sensory parameters of *peda.* Pal *et al.* (2005) [8] investigated the rheological properties of vacuum packed brown *peda* stored at 30 °C. Londhe and Pal (2008) [4] recorded the rheological properties of market samples of brown *peda* by using Micro stable Texture Analyzer. Patel *et al*. (2011) [10] studied the textural characteristics of *peda* marketed in Gujarat state by using

Instron Universal Testing Machine. Rasane *et al.* (2012) [11] studied the market samples of white *peda* manufactured in Varanasi for their textural properties. Shinde *et al.* (2015) [13] reported significant reduction in hardness of *peda* prepared using wheat bran. Srikanth and Kartikeyan (2017) [14] prepared *peda* with *aloe-vera* and concluded that textural characteristics of control *peda* significantly superior over rest of the treatments. However, no such investigation had been reported to evaluate the textural properties of extruded *peda* using product mix. The present study is therefore, an attempt to study the textural characteristics of fresh and stored samples of extruded *peda* prepared by using the *khoa*, skim milk powder and others (in different proportions) as ingredients equipped with extrusion technology for manufacturing.

Materials and Methods

Fresh, pasteurized full cream milk (brand Amul Gold, marketed by Gujarat Cooperative Milk Marketing Federation Limited, Anand) and skim milk powder (brand SAGAR, manufactured by Amul Fed Dairy), good quality *khoa* and *ghee* (brand *Devbhog*, Chhattisgarh State Cooperative Dairy Federation Limited, Urla, Durg), sugar and low-density polyethylene packaging material (dimensions 5x4x2.5 cm, thickness 130µm) was purchased from local market of Raipur city.

In this study, an attempt was made to utilize twin screw co-rotating food extruder system (Model: SY 30-IV, Jinan Saibainuo Technology Development Co. Ltd., China) for manufacturing *khoa* based sweet. Preliminary trials were conducted to optimize the operational parameters of twin screw extruder and ingredients for manufacturing extruded *peda*. Four product mixes namely C_1 (0% SMP, 70% *khoa* & 0% ghee); C_2 (5% SMP, 60% *khoa* & 05% *ghee)*; C_3 (10% SMP, 55% *khoa* & 05% *ghee*) and C_4 (containing 15% SMP, 50% *khoa* & 05% *ghee*) were selected and keeping sugar constant (@ 30%) and processed in a twin-screw extruder system at three-barrel temperatures i.e. 60^0C (T_1), 70^0C (T_2) & 80^0C (T_3) and three screw speeds i.e. 14 rpm (R_1), 21 rpm (R_2) and 28 rpm (R_3). The sensory data obtained during the course of research trials were statistically analyzed by using three factor factorial experiment design as described by Steel and Torrie (1980) [15]. On the basis of the results of sensory studies, following best three treatments were selected for further quality analysis were $C_3T_3R_1$, $C_3T_3R_2$ and $C_4T_2R_2$.

Manufacturing process for control and extruded *peda*

In this study, *khoa* was made traditionally from the fresh pasteurized full cream milk (6.15% fat and 9.27% SNF). It was then divided into four parts for making formulations/product mix. One part of *khoa* was used to make control *peda* while rest three parts were utilized to make product mix for experimental samples. The control sample of *peda was* manufactured according to standard procedure as suggested by Aneja*et al.* (2002) [1]. The extruded *peda* was prepared after setting all processing parameters in the extruder system according to the treatments. The product mix was prepared as per ratios in different treatments. Later, it was introduced into the feeding section of twin screw co-rotating extruder and processed at optimized system conditions. The extruder was emptied and cleaned after each run. During the extrusion processing, the product mixe was handled by the screw flight while moving and conveyed forward through a mixing/kneading section followed by evaporation/cooking section and finally extruded through the mould plate fitted at the exit. The mass of mix was collected in a clean tray for cooling to room temperature; round balls of *pedas* were formed manually weighing about 20-25 g each. The control and fresh samples of *peda* were analyzed for textural attributes.

Texture profile analysis

The Texture Analyzer (TA.XT Plus), using software Exponent Lite (Stable Microsystems, UK) was used for Texture Profile Analysis (TPA) of control and extruded *peda* samples. The *peda* samples were cut into cubes of 1cm^2 size. The mono axial compression of 5mm height and 75mm (P/75) compression platen probe were used to measure texture of *peda* samples at a temperature of 25±1^{0}C. The force distance curve was obtained for two bite compression cycle with test speed of 1mm/s and trigger force of 5g. The TPA graph was generated for plot of force (g) versus time (s). A typical two bite force distance curve of the *peda* sample is shown in Fig 1.

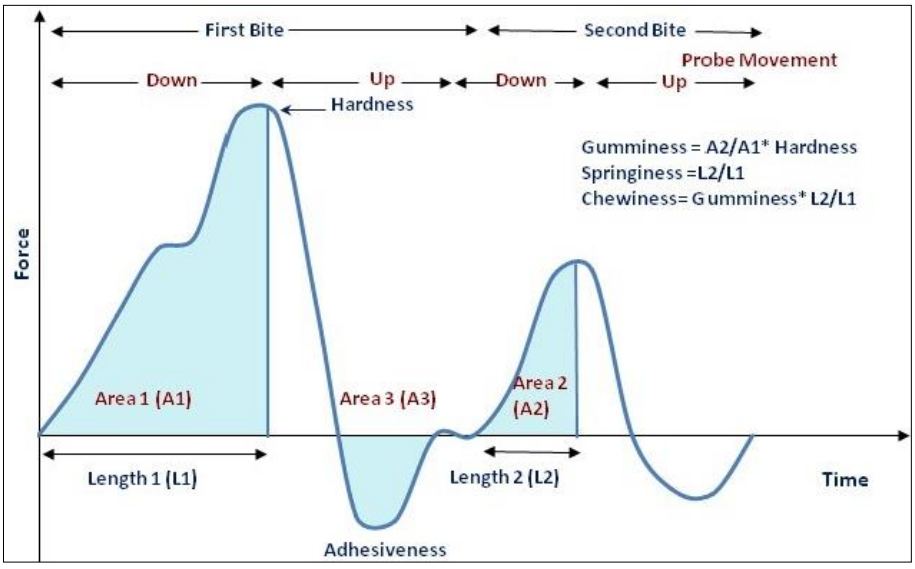


Fig 1: A typical two bite force distance curve of the texture profile analysis

Statistical analysis

The textural data obtained during the storage study of extruded *peda* were statistical analyzed by using Factorial Randomized Block Design with 4 treatments combinations (1 control + 3 experimental), 4 replications (samples) and storage period as described by Steel and Torrie (1980) [15].

Results and Discussion

The effect of ingredients and operating parameters on textural characteristics of extruded *peda* during storage at 37±1 °C for 7 daysand 7±1 °C for 20 days were studied. The changes in textural qualities with respect to hardness, adhesiveness, cohesiveness, springiness, gumminess and chewiness were studied.

Hardness (g)

The influence of ingredients and operating parameters on hardness of extruded *peda* during storage at 37±1 °C for 7 days and 7±1 °C for 20 days are shown in Fig. 2, respectively. It can be observed from Fig. 2(a) that the treatment $C_4T_2R_3$had the highest hardness values of 2120.94 g, while, treatment$C_3T_3R_1$had the lowest *(*1971.69 *g)* at storage at 37±1 °C. All the hardness values of different treatments and their interaction effect with storage period were found significantly ($p \leq 0.05$) different with each other (Table 1). Similar trends were reported by Patel *et al*. (1990) [12]; Jha *et al*. (2012) [3]. Londhe *et al*. (2012) [5] reported significant reduction in hardness value of laboratory made brown *peda* packed in card board box lined with butter paper from 86.14 N (87897 g) to 203.67 N (207824 g) at 30 °C for 20 days storage. Similar trend were observed during storage at 7±1 °C for 20 days, the hardness value was found significant ($p \leq 0.05$) among the treatments and also at every storage period (Table 2). The treatment $C_4T_2R_3$had the highest hardness values of 2041.87 g while, treatment$C_0T_0R_0$had the lowest hardness value of 1772.72 g. The hardness values significantly increased from 1745.36 g on 1st day to 2049.23 g on 20th day during storage at 7±1 °C (Fig. 2(b)). This could be attributed to the partial evaporation of moisture which would resulted in reduction in moisture content and consequently increase in hardness values.

Table 1: ANOVA for the effect of ingredients and operating parameters on textural properties of extruded *peda* during storage at 37±1 °C

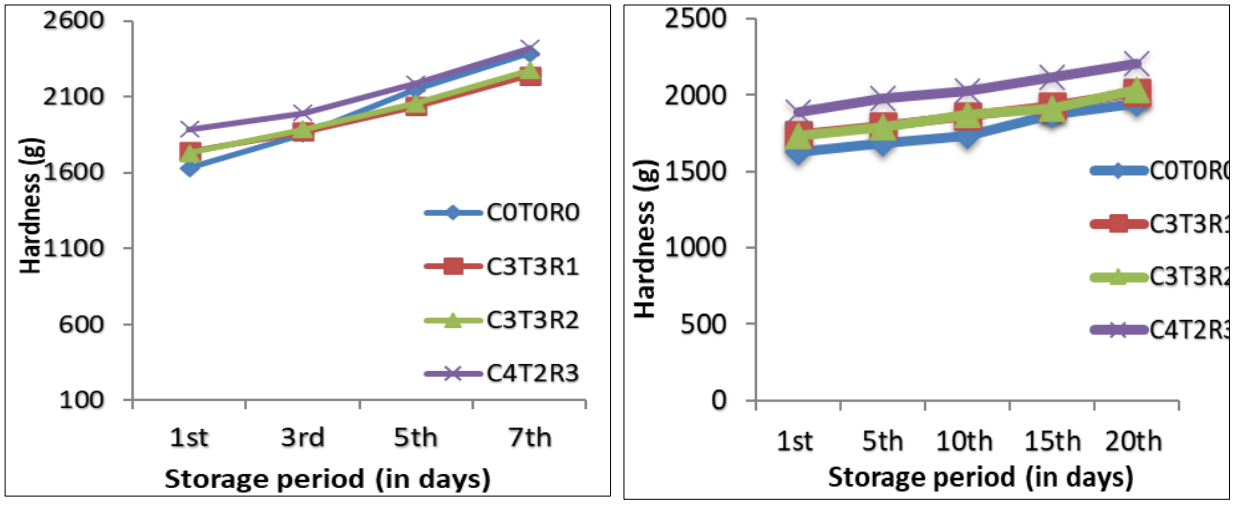
Source of Variation	DF	Hardness		Adhesiveness		Cohesiveness		Springiness		Gumminess		Chewiness	
		SE(m)	F-value	SE(m)	F-value	SE(m)	F-value	SE(m)	F-value	SE(m)	F-value	SE(m)	F-value
Treatment (T)	3	74124.23	480.31*	60.11	3.95*	0.00	81.49	0.00	34.93	446.93	197.37*	577.24	49.15*
Storage period (S)	3	1031342.91	6682.88*	466.19	30.67*	0.00	84.76	0.02	1242.19	157441.08	69529.49*	11683.93	994.86*
T x S	9	12002.89	77.77*	4.27	0.28	0.00	2.99	0.00	4.78	1893.64	836.27*	26.48	2.25*
Error	45	154.32	-	15.20	-	0.00	-	0.00	-	2.26	-	11.74	-

*significant ($p \leq 0.05$)

Table 2: ANOVA for the effect of ingredients and operating parameters on textural properties of extruded *peda* during storage at 7±1 °C

Source of Variation	DF	Hardness		Adhesiveness		Cohesiveness		Springiness		Gumminess		Chewiness	
		SE(m)	F-value	SE(m)	F-value	SE(m)	F-value	SE(m)	F-value	SE(m)	F-value	SE(m)	F-value
Treatment (T)	3	251534.05	9744.53*	43.84	2.18	0.00	12.72	0.00	33.21	4202.35	347.85*	420.38	25.93*
Storage period (S)	3	227458.45	8811.83*	253.99	12.61	0.01	142.12	0.00	39.25	34901.77	2889.02*	186.57	11.51*
T x S	9	1311.08	50.79	2.57	0.13	0.00	6.08	0.00	0.21	145.65	12.06*	8.51	0.52*
Error	45	25.81	-	20.15	-	0.00	-	0.00	-	12.08	-	16.21	-

*Significant ($p \leq 0.05$)



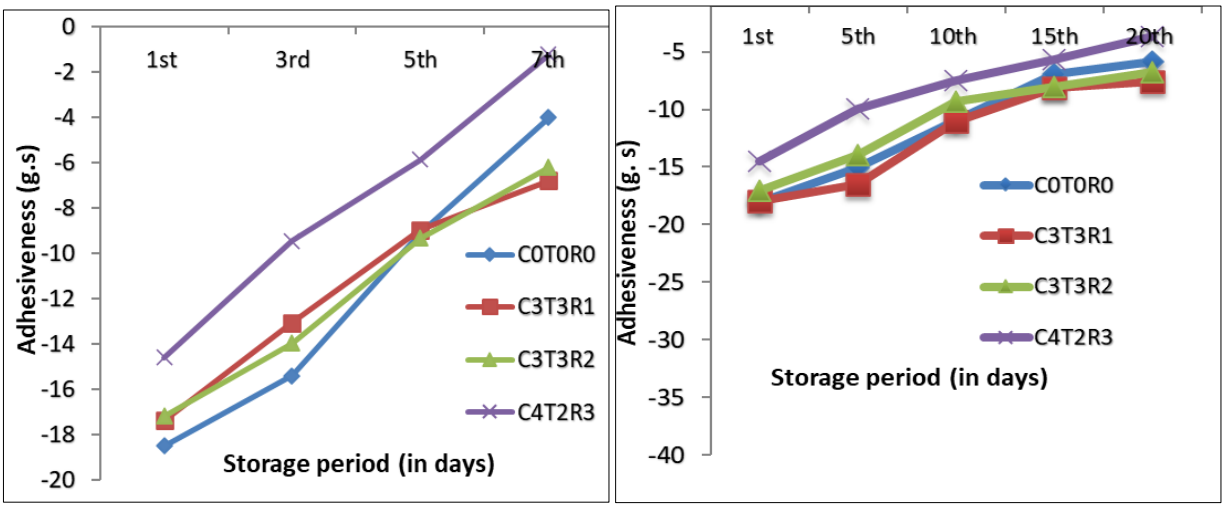
(a) (b)

Fig 2: Effect of ingredients and operating parameters on hardness value of extruded *peda* during storage at (a) 37±1^{0}C and (b)7±1^{0}C

Adhesiveness (g. s)

Average adhesiveness value was lowest for treatment $C_4T_2R_3$(-7.79 g.s), while control sample$C_0T_0R_0$ (-11.77 g.s) showed highest adhesiveness. The adhesiveness values decreased from-16.93 g.s to -4.56 g.s during 1-7 day of storage at 37±1 °C. During storage the adhesiveness value decreased significantly at every stage of storage period at both temperatures at 5% level of significance respectively (Table 1

and 2). The decreased in the adhesion could be due to the lower moisture content in experimental samples. Similar result was reported by Londhe *et al*. (2012) [5] who reported decrease in adhesiveness value of laboratory made brown *peda* packed in card board box lined with butter paper from initial value of 52.43 N.mm (5350 g. s) to 39.46 N.mm (4026.5 g.s) during storage at 30 ^{0}C. Jha *et al*. (2012) [3] also reported significant (p<0.01) reduction in adhesiveness value of *peda* from 107.53 to 76.24 g. s during 9 days of storage at 37^{0}C.*Peda* prepared from treatment $C_3T_3R_1$ had the maximum adhesiveness value (-12.13 g.s) while, it was lowest in treatment $C_4T_2R_3$(-8.28 g.s.) during storage at 7±1 °C.

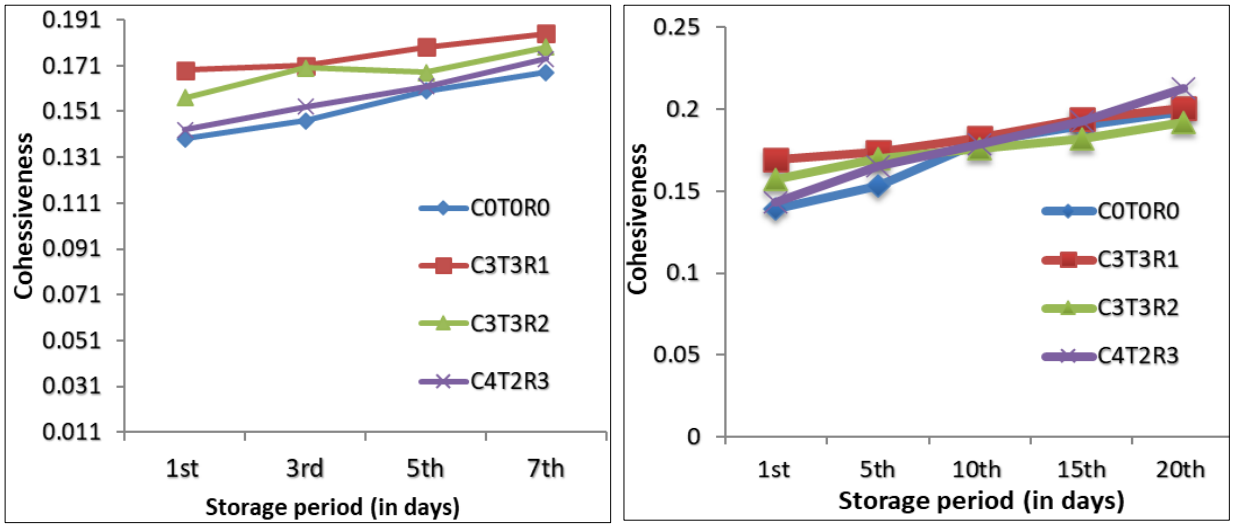


a) b)

Fig 3: Effect of ingredients and operating parameters on adhesiveness value of extruded *peda* during storage at (a) 37±1 °C and (b) 7±1 °C.

Cohesiveness

The highest cohesiveness value of 0.176 was recorded for treatment $C_3T_3R_1$andthe control sample ($C_0T_0R_0$) had the lowest cohesiveness value (0.153) during storage at 37±1 °C (Fig. 4(a)). Statistically, it was found non-significant (p≤0.05) during storage at 37±1 °C (Table 1). The maximum cohesiveness had recorded for the product made out from treatment $C_3T_3R_1$ during storage at 7±1 °C (Fig. 4(b)). Statistically, the treatment effect, storage period and their interaction effect were found non-significant at 5% level of significance (Table 2).

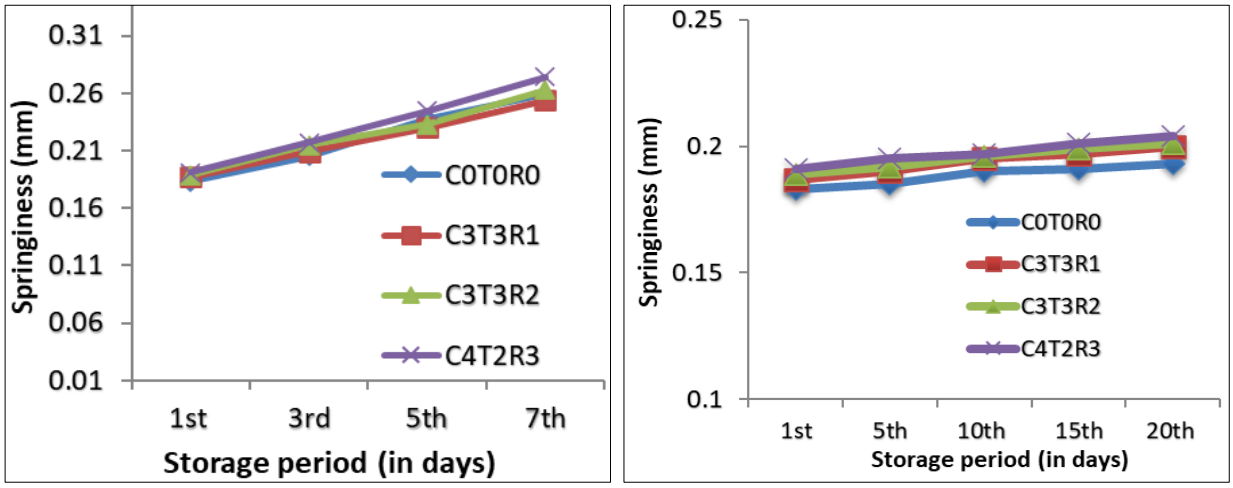


a) b)

Fig 4: Effect of ingredients and operating parameters on cohesiveness value of extruded *peda* during storage at (a) 37±1^{0}C and (b) 7±1^{0}C.

Springiness (mm)

The effect of ingredients and operating parameters on springiness of extruded *peda* during storage at 37±1 °C and 7±1 °C is shown in Fig 5. It can be interpreted from graph that treatment $C_4T_2R_3$ had slightly higher springiness value while treatment $C_0T_0R_0$ had lowest (Fig. 5(a)). The ANOVA showed non-significant (p≤0.05) effect of ingredients and operating parameters on springiness value of extruded *peda* samples w.r.t. treatment, storage period at both temperatures and their interaction (Table 1 & 2). The treatment $C_4T_2R_3$ sample had slightly higher springiness value (0.198 mm), while, $C_0T_0R_0$ (control) had lowest (0.188 mm) at storage temperature 7±1 °C (Fig. 5(b)).



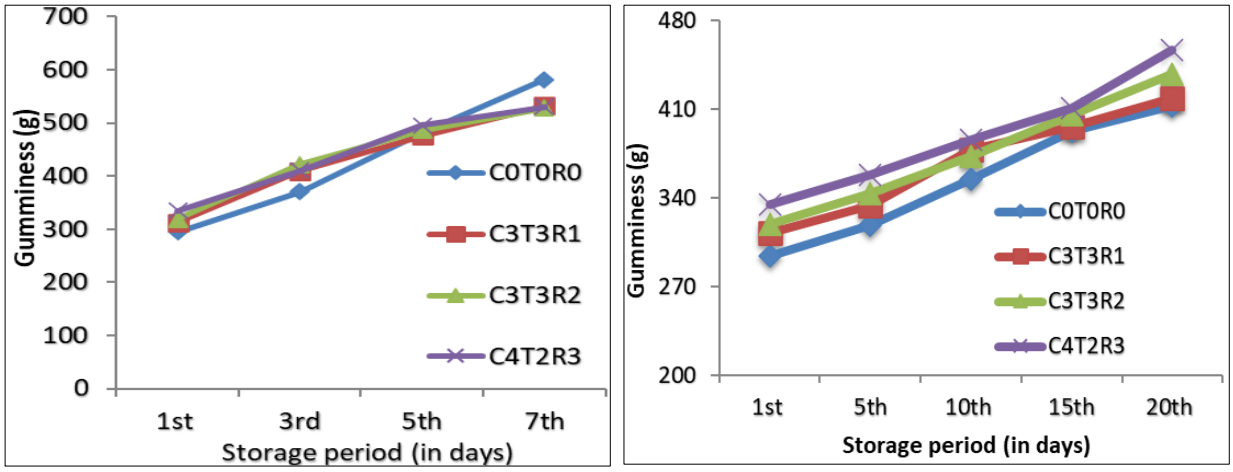
a) b)

Fig 5: Effect of ingredients and operating parameters on springiness value of extruded *peda*during storage at (a) 37±1^{0}C and (b) 7±1^{0}C.

Gumminess (g)

It was observed that treatment $C_4T_2R_3$had the highest gumminess value (443.00 g) and $C_0T_0R_0$ (control) had the lowest (431.93 g) from Fig. 6(a). Among the experimental samples, the treatments$C_3T_3R_1$, $C_3T_3R_2$ and$C_4T_2R_3$ were found at par. The samples of *peda* showed significant (p≤0.05) increase in gumminess from 315.40 to 543.49 during storage at 37±1^{0}C up to 7days (Table 1). Similar result was reported by Londhe *et al*. (2012) [5] reported increase in gumminess value from 13.17 N (1343.8 g) to 52.29 N (5335.71 g) of laboratory made brown *peda* packed in cardboard box lined with butter paper during storage at 30^{0}C for 20 days. The combined effect of storage and treatment together results in significant increase in the gumminess values of *peda* samples. This could be attributed to partial evaporation of moisture and also the physico-chemical changes that would had taken place during manufacturing process.

It could be inferred from Fig. 6(b) that the when screw speed increased from 14 to 28 rpm, there was an increase in the gumminess of the product with increase in level of skim milk powder. The gumminess (g) of the *peda* samples varied from 354.55 g ($C_0T_0R_0$) to 389.19 g ($C_4T_2R_3$). The gumminess was found to be significant (p≤0.05) at every stage of storage period at 7±1^{0}C and interaction effect with treatment (Table 2).



a) b)

Fig 6: Effect of ingredients and operating parameters on gumminess value of extruded *peda* during storage at (a) 37±1^{0}C and (b) 7±1 °C

Chewiness (g. mm)

It was observed that treatment $C_4T_2R_3$had the highest cohesiveness value (95.81 g.mm) while, control $C_0T_0R_0$had the lowest chewiness value (81.25 g.mm) from Fig.7 (a). Treatment $C_3T_3R_1$ and $C_3T_3R_2$were found to be at par with each other while they significantly (p≤0.05) differ from the treatment combinations $C_0T_0R_0$ and $C_4T_2R_3$.The extruded *peda* samples were significant increase in chewiness from 62.43 to 124.68 g. mm during storage at 37±1 °C for 7days at 5% level of significance. It might be due to gradual increase in hardness, cohesiveness and springiness values. The interaction effect between treatment and storage was found to be significant. The combined effect of storage (at 37 °C and 7 °C) temperatures and treatment together resulted in significant (p≤0.05) increased in the chewiness values of *peda* samples. This could be attributed to partial evaporation of moisture, increase in level of skim milk powder and screw speed during manufacturing process.

The extruded *peda* samples showed significant (p≤0.05) increase in chewiness from 62.42on 1st days to 70.92 g.mm on 20th days during storage at 7±1 °C. This might be due to gradual increase in hardness, cohesiveness and springiness value. The chewiness was found to be significant at 5% level of significance at every stage of storage period and their interaction with treatments were also found to be significant (Table 2).

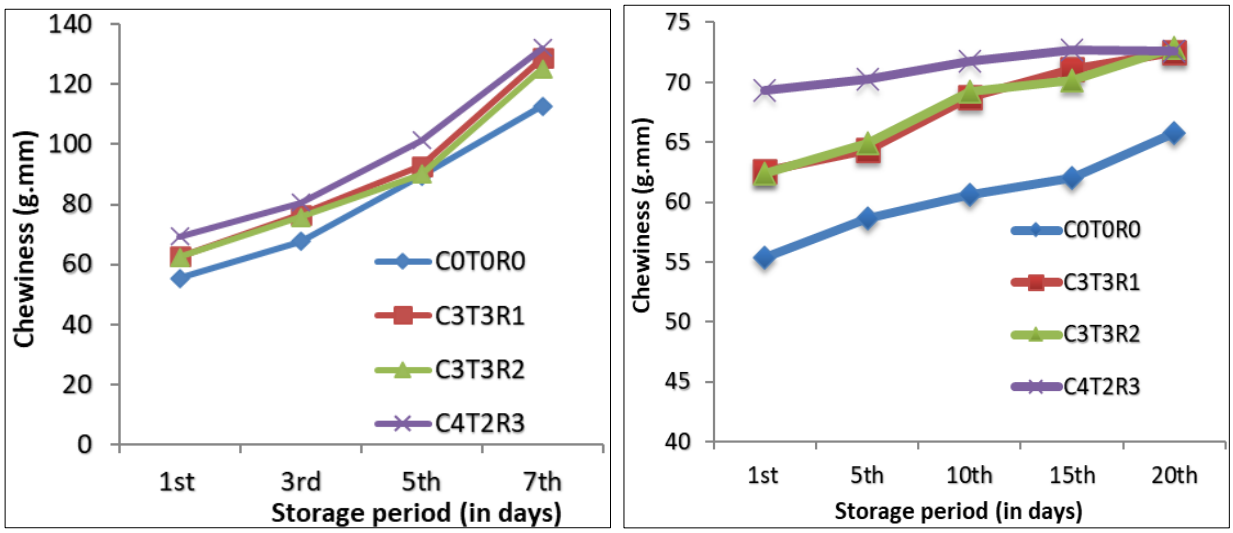


Fig 7: Effect of ingredients and operating parameters on chewiness value of extruded *peda* during storage at (a) 37±1^{0}C and (b) 7±1^{0}C

Conclusions

The textural characteristic of any food is the quality parameter affecting food preference. During storage, hardness, adhesiveness, gumminess and chewiness were the important textural properties affecting the quality of extruded *peda*. The treatment and storage period had no significant effect on the cohesiveness and springiness values of extruded *peda* samples. The best quality extruded *peda* in terms of textural characteristics after control sample can be produced by keeping process parameters of barrel temperature of 80^{0}C, screw speed of 14 rpm and feed compositions containing of 10% SMP, 55% khoa, 5% ghee and 30% sugar.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Aneja RP, Mathur BN, Chandan RC, Bannerjee AK. Technology of milk products. A Dairy India Publication, New Delhi; c2002.
2. Bandyopadhyay M, Mukherjee RS, Chakraborty R, Raychaudhari U. A survey on formulations and process techniques of some special Indian traditional sweets and herbal sweets. Indian Dairyman. 2006;58(5):23-25.
3. Jha A, Kumar A, Jain P, Om H, Singh R, Bunkar DS. Physical-chemical and sensory changes during storage of *lal peda*. J Food Sci Technol. 2012;63(5):17-19.
4. Londhe G, Pal D. Studies on the quality evaluation of market samples of brown *peda*. Indian J Dairy Sci. 2008;61(6):347-352.
5. Londhe G, Pal D, Raju PN. Effect of packaging techniques on shelf life of brown *peda*, a milk-based confection. LWT- Food Science and Technology, DOI: 10.1016/j; c2012. p. 118-126.
6. Londhe GK. Development of a process for manufacture and shelf-life extension of brown *peda*. Ph.D. Thesis, NDRI, Karnal, India; c2006.
7. Naresh L, Venkateshaiah BV, Arun Kumar H, Venkatesh M. Studies on effect of microwave heat processing on physio-chemical sensory and shelf life of *peda*. Indian J Dairy Sci. 2009;62(4):262-266.
8. Pal D, Verma BB, Dodeja AK, Mann B, Garg FC. Up-gradation of the technology for manufacture of *Rabri*. Annual Report, NDRI, Karnal; c2005.
9. Patel AA, Patil GR, Garg FC, Rajorhia GS. Texture of peda as measured by instron. In: Proceedings of XXIII Int. Dairy Cong., Brief Communication. Montreal, Canada; c1990.
10. Patel HA, Salunke S, Thakur PN. Instrumental texture profiling of *peda* marketed in Gujarat state. Int. J Dairy Foods. 2011;1(1):68-75.
11. Rasane P, Arvind, Jha A. Textural and sensory characteristics of market samples of *peda* manufactured in Varanasi city of India. J Dairying, Foods & H.S. 2012;31(4):239-243.
12. Sandey KK, Goel BK, Karthikeyen S, Agrawal AK, Uprit S, Choudhary KK. Effect of processing parameters of twin screw extruder and product mix on sensory quality of fresh extruded *peda*.Intl. J Chemical Studies. 2018;6(6):2746-2750.
13. Shinde AT, Lingayat NT, Jadhav BA, Korake RL. Effect of wheat bran on chemical composition and textural profile of *Peda.* Asian J Dairy Food Res. 2015;34(3):193-197.
14. Srikanth K, Kartikeyan S. Effect of *aloe vera* juice incorporation on texural and sensory characteristics of the *peda* during storage at 37±1 °C. Intl. J Food Nutri. Sci. 2017;6(3):108-118.
15. Steel RGD, Torrie JH. Principles and procedures of statistics – a biometrical approach, 2nd Edition, McGraw Hill, New York; c1980.
16. Suryawanshi SU, Shelke RR, Wadhave SN, Kokate PG. Chemical composition of *peda* prepared from cow milk blended with skimmed milk powder. Asian J Animal Sci. 2014;9(1):106-108.
17. Thompkinson DK, De S. Utilization of dried *khoa* for *peda* making. J Food Sci. Technol. 1981;18:259-260.