Process standardization for the manufacture of *Thabdi Peda*

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Revised: 18 April 2014 / Accepted: 21 April 2014 / Published online: 2 May 2014
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Abstract Traditional dairy products in India are manufactured using age old methods. Such methods varies from place to place. For industrial production of such products a standardized process is needed. Present study was designed to arrive at a method of manufacture for *Thabdi Peda*, a very popular sweet in Saurashtra region of Gujarat. Range of process parameters like fat percent of milk (4 to 8 %), rate of sugar addition (6 to 10 %) and duration of final heat desiccation (20 to 60 min) were studied and optimum values determined using Response Surface Methodology (RSM) with central composite rotatable design (CCRD). The samples obtained from trials were analyzed for sensory, physicochemical, compositional and textural attributes. The optimized process developed with 10 kg batch of milk having 6 % fat, 8.33 % rate of sugar addition and 34 min duration of heating produced most acceptable product. Standardized *Thabdi Peda* was found to contain on an average 16.80 % fat, 17.48 % moisture, 11.25 % protein, 20.95 % lactose, 29.99 % sucrose, 3.53 % ash and it gave 28.75 % yield. The pH, water activity and HMF (μ Mole/100 g) content were 6.42, 0.807 and 121.91 respectively. Standard plate count, Yeast and Mold counts were observed to be 3.68 log cfu/g, and 2.51 log cfu/g respectively. No coliforms were observed in *Thabdi Peda*.

Keywords *Thabdi peda* · Heat desiccation · Sensory · Texture · Physico-chemical

Introduction

Since time immemorial, traditional Indian milk products have been an inseparable part of the socio-cultural life of India and have great social, religious, cultural, medicinal and economic importance. Thus, traditional milk products represent the most prolific segment of the Indian dairy industry. Each of these indigenous products has its unique flavor, texture, and appearance (Pal and Raju 2010). At the current level of about 127.3 million tonnes of annual milk production in India, it is estimated that about 50 % of the total milk produced is converted into traditional milk products (Bhasin 2012). In addition to preservation of milk solids for longer time at room temperature, manufacture of traditional dairy products add value to milk and also provide considerable employment opportunity. The market for this largest and fast growing segment of Indian dairy industry is estimated at ₹ 75,000 crores (Parekh 2013). Traditional dairy products not only have established market in India but also have a great export potential because of strong presence of Indian diaspora in many parts of world (Londhe et al. 2006). Hence, a very good scope exists for the traditional Indian dairy products which are region specific but have a good potential to become popular outside the region also. *Thabdi Peda* is one of such heat desiccated indigenous milk sweet manufactured and sold in large quantities in Saurashtra region of Gujarat State (Patel et al. 2012). The product resembles to brown *peda* in many aspects. However, the scientific literature pertaining to the manufacture of this product is very limited and so to fulfil the gap of scientific knowledge, an attempt is made here to standardize its method of manufacture

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by standardizing fat percent of milk, rate of sugar addition and duration of final heat desiccation.

Materials and methods

Materials used

The whole milk used for manufacturing *Thabdi Peda* was procured from Anubhav Dairy, Anand Agricultural University, Anand. Good quality granular sugar used as a sweetener for *Thabdi Peda* was procured from the local market of Anand.

Basic process of *Thabdi Peda* preparation

Fresh milk procured was strained, standardized to required fat (ranging from 4 to 8 %) and 9 % SNF. The standardized milk was then heated in batch of 10 kg milk in a stainless steel direct gas fired revolving kettle with thick iron plate bottom equipped with vertical as well as horizontal scrapers. The kettle is also attached with a variable speed drive which regulates speed of the kettle as per need. Sugar is added at first boiling as per requirement of study (6 to 10 % by weight of milk) and the process of heating and agitation continued until the pre-pat formation stage. At this stage, heating and agitation was stopped and whole mass was kept undisturbed for some time until the milk was coagulated with separation of little watery part and it was converted in to granular mass. Further heating with agitation was started for few minutes to evaporate extra moisture and development of colour and flavour in final product (Duration of desiccation varied from 20 to 60 min after pre-pat formation stage). The hot mass was unloaded in to a clean and dry, stainless steel tray, formed in to *peda* and cooled to room temperature and packed as required.

Experimental design

The central composite rotatable design was used for designing the experimental combinations (Modha and Pal 2011). The experiment was designed using software Design Expert version 8.0.3. The variables used were fat percent of milk, rate of sugar addition and duration of desiccation and level of these variables along with experimental plan consisting of three variables at five levels has been shown in Table 1. The

variables were standardized to simplify computation and to deduce the relative effect of variables on response. The magnitude of the coefficients in second order polynomial shows the effect of that variable on the response.

Analysis

Compositional analysis

The moisture of the *Thabdi Peda* samples was determined as per the procedure described in Indian Standard: 2785 (1979) using Mojonnier Milk Tester Model-D. Fat extraction of *Thabdi Peda* was determined as per the procedure described in Indian Standard: 2311 (1963). Total nitrogen/protein of *Thabdi Peda* was determined by Semi-Microkjeldahl method (Indian Standard: 1479-Part-II, 1961), using Kjehl-plus Digestion System (Model-KPS 006 L, M/s. Pelican Instruments, Chennai) and Kjehl-plus Semi-Automatic Distillation System (Model-Distil M, M/s. Pelican Instruments, Chennai). Reducing (lactose) and non-reducing (sucrose) sugars were determined by the volumetric method specified for ice-cream in Indian Standard: 2802 (1964). Ash content of the samples was determined by procedure described in Indian Standard: 1547 (1985).

Physico-chemical quality analysis

Titrateable Acidity of samples was determined by procedure described as per Indian Standard: 1166 (1968). The pH of *Thabdi Peda* was measured using method described by Franklin and Sharpe (1963). The water activity (a_w) of *Thabdi Peda* samples, tempered at 25 °C temperature, was measured using Rotronic Hygroskop Model: Hygrolab-3 (M/s. Rotronic ag, Switzerland) (Hirpara et al. 2013). Soluble nitrogen content of *Thabdi Peda* samples was determined by the procedure outlined by Kosikowaski (1982). The method prescribed by Deeth et al. (1975) was used to estimate the FFA content of *Thabdi Peda*. The quantitative method presented by Keeney and Bassette (1959) for quantifying HMF by spectrophotometric measurement of the 2-thio barbituric acid (TBA) reaction product was used to assess the extent of browning in *Thabdi Peda* samples with slight modification.

Texture profile analysis

Four samples of each experimental *Thabdi Peda* were tempered to 23 ± 1 °C and then subjected to uniaxial compression to 80 % of the initial sample height, using a Food Texture Analyzer of Lloyd Instruments LRX Plus material testing machine, England; fitted with 0–500 kg load cell. The force-distance curve was obtained for a two-bite deformation cycle

Table 1 Coded and decoded levels of the experimental independent variables used in central composite rotatable design

Independent variables (coded)	−1.68	−1	0	1	1.68
Fat, % by wt. of Milk, X_1	2.6	4	6	8	9.4
Sugar, % by wt. of Milk, X_2	4.64	6	8	10	11.36
Duration of Heating, Min, X_3	6.4	20	40	60	73.6

employing a Cross Head speed of 50 mm/min, Trigger 10 gf and 80 % Compression.

Sensory evaluation

The *Thabdi Peda* samples were evaluated using a 9-point hedonic scale (Stone et al. 1974) by group of eight trained judges selected on the basis of Duo-trio test. The judges were also requested to give criticism for each attributed of the samples.

Microbiological analysis

All the *Thabdi Peda* samples were analyzed for the Standard Plate Count (SPC), Coliform count and Yeast and Mold count (YMC) by the methods described in Indian Standard: 5550 (2005) with slight modification.

Statistical analysis

The experiment was designed and responses were analyzed using software Design Expert version 8.0.3. All physico-chemical determinations were average of three replicates, whereas sensory data were average of eight replicates. Table 2 shows the treatments to be experimented with reference to the Central Composite Rotatable Design for Three

Table 2 Experimental Design Matrix (CCRD) for levels of factors: milk fat (%), sugar addition (%) and duration of heat treatment (mins)

Run order	X ₁ Fat %	X ₂ Sugar %	X ₃ Heating time Min
1	8.0	10.00	60.0
2	4.0	10.00	20.0
3	6.0	8.00	73.6
4	4.0	6.00	20.0
5	9.4	8.00	40.0
6	6.0	4.64	40.0
7	6.0	8.00	6.4
8	2.6	8.00	40.0
9	6.0	11.36	40.0
10	8.0	6.00	20.0
11	8.0	6.00	60.0
12	6.0	8.00	40.0
13	4.0	10.00	60.0
14	6.0	8.00	40.0
15	8.0	10.00	20.0
16	4.0	6.00	60.0
17	6.0	8.00	40.0
18	6.0	8.00	40.0
19	6.0	8.00	40.0
20	6.0	8.00	40.0

Independent Variables: Milk Fat (%), Rate of Sugar Addition (%) and Duration of Heat Treatment (minutes) in actual values.

Results and discussion

Effect of variables on properties of *Thabdi Peda*

A second order polynomial was fitted into the data for all responses and the actual values observed are reported in Table 3.

$$Y = \beta_0 + \sum_{i=1}^3 \beta_i X_i + \sum_{i=1}^3 \beta_{ii} X_i^2 + \sum_{i,j=1 \neq j}^3 \beta_{ij} X_i X_j$$

Where β_0 , β_i , β_{ii} , β_{ij} =Regression coefficients, X_i , X_j =independent variables, Y =dependent variable.

$R^2 > 0.80$ for sensory attributes is statistically adequate for developing a model or equation (Henika 1982). Presently R^2 was > 0.80 for all the sensory responses (Table 3). The probability value (p) showed the adequacy of the models so used to describe the effect of variables on different responses. The effect of fat, sugar and duration of heating on the responses is shown in equations below. The sign and magnitude of coefficients indicate the effect of the variable on the responses. The models thus developed with coded variables are as follows:

$$\text{Colour \& Appearance} = 7.84 + 0.099X_1 + 0.098X_2 - 0.60X_3 + 0.046X_{12} - 0.0062X_{13} - 0.19X_{23} + 0.10X_1^2 - 0.37X_2^2 - 1.18X_3^2$$

$$\text{Body \& Texture} = 7.90 + 0.087X_1 + 0.061X_2 - 0.66X_3 + 0.24X_{12} + 0.18X_{13} - 0.24X_{23} + 0.052X_1^2 - 0.54X_2^2 - 1.04X_3^2$$

$$\text{Flavour} = 7.96 - 0.024X_1 + 0.061X_2 - 0.80X_3 + 0.36X_{12} - 0.099X_{13} - 0.26X_{23} + 0.041X_1^2 - 0.42X_2^2 - 1.16X_3^2$$

$$\text{Overall Acceptability} = 7.96 + 0.020X_1 + 0.091X_2 - 0.64X_3 + 0.21X_{12} - 0.047X_{13} - 0.24X_{23} + 0.051X_1^2 - 0.50X_2^2 - 1.14X_3^2$$

$$\text{Fat (\%) in Peda} = 17.12 + 5.88X_1 - 2.42X_2 + 0.53X_3 + 0.073X_{12} + 0.87X_{13} - 0.24X_{23} - 0.22X_1^2 + 0.39X_2^2 + 0.39X_3^2$$

$$\text{Moisture (\%) in Peda} = 16.03 - 0.32X_1 + 0.0059X_2 - 3.05X_3 + 0.51X_{12} - 0.055X_{13} - 0.19X_{23} - 1.04X_1^2 - 1.23X_2^2 - 1.55X_3^2$$

$$\text{Hardness (N)} = 734.50 - 176.49X_1 - 11.65X_2 + 678.91X_3 - 79.15X_{12} -$$

Table 3 Scores of sensory, compositional, textural and physico-chemical properties of *Thabdi Peda*

Run order	C & A	B & T	Flavour	OA	Fat (%)	Moisture (%)	Hardness (N)	Water activity	FFA (μ eq/g)	HMF (μ moles/100 g)
1	6.16	5.90	5.50	5.73	23.47	10.56	1,743.34	0.641	1.04	423.50
2	6.90	7.00	6.95	6.98	10.30	14.57	769.04	0.776	0.80	388.50
3	3.00	4.00	3.50	3.70	19.08	3.36	2,619.73	0.427	1.49	584.50
4	6.25	7.00	7.15	6.68	12.94	15.99	673.56	0.838	0.59	374.50
5	8.25	8.30	8.10	8.24	26.09	10.94	864.23	0.723	0.72	446.25
6	6.86	6.50	6.80	6.64	23.49	10.84	978.11	0.738	0.66	253.75
7	6.12	6.20	6.10	6.00	17.87	17.64	254.56	0.864	0.63	185.50
8	8.13	8.10	8.30	8.20	7.39	12.97	1,633.44	0.728	0.59	306.25
9	6.88	6.57	7.00	6.70	13.47	11.97	815.22	0.779	1.23	392.00
10	6.50	6.20	6.50	6.35	24.36	14.53	599.65	0.823	1.72	232.75
11	6.07	5.87	5.31	5.56	26.77	10.71	1,787.99	0.689	1.50	154.00
12	7.85	8.00	8.06	7.97	15.82	14.07	710.69	0.774	1.26	101.50
13	5.75	5.00	5.10	5.40	8.30	10.21	2,234.34	0.674	2.38	157.50
14	8.00	7.95	7.95	8.00	17.20	16.85	716.77	0.785	0.51	50.75
15	7.25	7.50	8.00	7.60	19.82	15.80	385.15	0.783	0.86	73.50
16	5.93	5.62	6.10	5.98	14.08	11.73	1,955.78	0.639	0.84	108.50
17	7.69	7.92	8.03	8.00	17.93	16.06	685.23	0.746	0.79	98.00
18	8.13	7.86	7.81	8.06	17.48	16.29	722.87	0.759	0.65	80.50
19	7.87	7.93	7.97	7.91	18.01	16.03	811.21	0.712	0.73	59.50
20	7.50	7.68	7.87	7.75	16.21	17.27	769.23	0.796	1.22	285.25
R ²	0.9505	0.9859	0.9918	0.9903	0.9804	0.8461	0.9924	0.8721	0.7732	0.5609

C & A colour and appearance score, B & T body and texture score, OA overall acceptability, FFA free fatty acids

$$\begin{aligned}
 &25.12X_{13}+44.12X_{23}+191.15X_1^2+66.64X_2^2+257.73X_3^2 \\
 \text{Water Activity (a}_w\text{)} &=0.76+0.00004X_1-0.0034X_2-0.096X_3-0.0076X_{12}+0.0031X_{13}+0.011X_{23}-0.0074X_1^2+0.00433X_2^2-0.036X_3^2 \\
 \text{FFA (}\mu\text{ eq/g)} &=0.85+0.052X_1+0.10X_2+0.24X_3-0.38X_{12}-0.23X_{13}+0.22X_{23}-0.002487X_1^2+0.098X_2^2+0.14X_3^2 \\
 \text{HMF (}\mu\text{ moles/100 g)} &=117.02+6.60X_1+29.71X_2+32.61X_3+5.91X_{12}+96.03X_{13}+57.97X_{23}+64.23X_1^2+45.36X_2^2+67.32X_3^2
 \end{aligned}$$

Effect of variables on sensory responses

Sensory scores of *Thabdi Peda* for Colour and Appearance varied from 3.0 to 8.1, Body and Texture 4.0 to 8.3, Flavour 3.5 to 8.3 and Overall Acceptability ranged from 3.7 to 8.2. Above equations shows that duration of heating affected most of the sensory responses of *Thabdi Peda* at linear level i.e., a slight change in duration of heating causes significant change in the sensory properties of *Thabdi Peda*. While interactions

between levels of Fat and Sugar and Duration of heating and Sugar affected all the sensory responses significantly except colour and appearance (C & A). Body and texture scores (B & T) were affected significantly by all the interactions.

Colour and appearance of the *Thabdi Peda* was affected significantly by duration of heating due to production of brown pigments, while sugar affected colour and appearance at higher levels only. Hirpara et al. (2013) observed a consistent increase in colour & appearance score of *Thabdi* when the levels of sugar addition was raised from 6 to 10 %. Also they found that the duration of heating has negative effect on colour and appearance score. *Thabdi Peda* prepared by using 9.4 % fat of milk, 8 % rate of sugar addition and 40 min duration of heating was rated best for colour & appearance by the panelists.

Body and texture score of *Thabdi Peda* ranged from 4.0 to 8.3 on 9-Point Hedonic Scale. *Thabdi Peda* made by 9.4 % fat of milk, 8 % rate of sugar addition and 40 min duration of heating scored highest for body and texture. Duration of heating showed its significance in quadratic terms. This indicates that the increase in duration of heating decreases the body and texture score significantly at higher level because of more hard and dry body and coarse grains due to excessive evaporation of moisture, while higher sugar and fat

levels enhances body and texture score at linear level by giving soft body and smooth granules. Higher levels of sugar and duration of heating has inverse effect on body and texture of *Thabdi Peda*. Interaction of fat and sugar has significant positive effect on the body and texture of product, because fat softens the body while sugar hardens it and balance between both gives desirable body and texture to the product. Suresh and Jha (1994) also reported the positive influence of fat content of milk on the body and texture score of the *Kalakand*. Thus, the fat content, sugar level and heating time when used judiciously gives the optimum results on body and texture score of *Thabdi Peda*.

Flavour is probably the most important criteria for measuring the quality of product, which in turn determines its acceptability. The increase in fat level of milk and duration of heating decreases the flavour score significantly at higher levels because higher fat causes more free fat, which is undesirable and higher duration of heating causes burnt flavor, while sugar has positive effect on flavour score of product at linear level due to increase in sweetness and caramelized flavour, but reverses significantly at quadratic level because of undesirable burnt flavor in the product. Sugar has a major role to play in this product as its interaction with both the other factors yield significant change in flavor score of *Thabdi Peda*.

Overall acceptability is the indicative parameter of sensory quality of product in totality and consists of appearance, flavour, body and textural characteristics. Overall acceptability of the product was found dependent mostly on duration of heating, the significance of level of sugar at higher level indicated the decrease in overall acceptability after attaining a particular value. Fat level in milk has not much effect on overall acceptability of *Thabdi Peda*. The response surface for overall acceptability scores in relation to fat, sugar and duration of heating are shown in Fig. 1. A significant positive interactive effect on overall acceptability was observed with both fat level of milk and rate of sugar addition. Ravi et al.(2005) also reported that with the increase in the fat level, significant ($P<0.01$) increase was observed in the overall

acceptability scores of *Milk Cake* made from cow milk. The overall effect of duration of heating was maximized followed by level of sugar and fat on sensory characteristics.

Effect of variables on compositional and textural responses

Compositional and textural attributes chosen for product standardization for the manufacture of *Thabdi Peda* are its fat %, moisture % and hardness (N). The values of fat % in *Thabdi Peda* ranged from 7.39 to 26.77 % and product made using 8 % fat of milk, 6 % sugar and 60 min of heating had the highest fat level in *Thabdi Peda*. The level of fat increases with increase in fat level in milk up to a particular point then it decreases at higher levels due to sticking of extra free fat on the vessel due to scraping. Patel and Upadhyay (2003) also observed that increase in fat: SNF ratio causes increase in fat level in *Basundi*. Sugar has a significant negative effect on fat % of product at linear level. Thus as the sugar content increases fat content of *Thabdi Peda* decreases significantly. Significant positive interactive effect on fat level in *Thabdi Peda* was observed with fat of milk and duration of heating. This may be due to loss of moisture during heating and thus, increasing the level of fat in final product.

Moisture content is the compositional attribute of *Thabdi Peda*, which decides the acceptability of the product through its texture forming characteristics. The values of moisture content in *Thabdi Peda* ranged from 3.36 to 17.64 %. Moisture content was influenced by both fat and duration of heating, but the effect of heating time was significant due to more moisture loss with increase in duration of heating. In interactions also effect of duration of heating is seen clearly on moisture content of product. Thus, moisture content in *Thabdi Peda* is inversely related with the duration of heating. However, the fat and sugar levels both affect the moisture content by replacing the moisture proportionately in the product.

The values of hardness ranged from 254.56 to 2,619.73 N. The level of fat in milk and sugar has inverse effect on Hardness of *Thabi Peda* may be due to softening effect

Fig. 1 Effect of fat, sugar and duration of heating on overall acceptability of *Thabdi Peda* (design expert plots), OA overall acceptability

Fig. 2 Effect of fat, sugar and duration of heating on Hardness of *Thabdi Peda* (design expert plots)

provided by fat and humectant type effect of added sugar up to certain extent, while duration of heating has positive effect due to moisture loss. Significant negative interactive effect was observed with fat of milk and level of sugar, as both fat and sugar levels has negative effect on hardness individually. Fat and duration of heating has significant effect at linear level and all the three factors have significant effect at higher level on hardness. Gupta et al. (1990) also observed that an increase in total solids was accompanied by a considerable increase in Instron hardness of *Khoa*. The response surface plots as shown in Fig. 2 are based on the above model.

Effect of variables on physicochemical responses

All the physicochemical parameters selected are affected by duration of heating. Water activity (a_w) in *Thabdi Peda* is a major attributes which acts as an important hurdle for storage

Table 4 Comparison of predicted and actual values of responses for optimized *Thabdi peda*

Attribute	Predicted value ^a	Actual value ^b	Cal. <i>t</i> -value*
C & A	7.932	8.111	2.4349
B & T	8.0104	7.972	0.1619
Flavour	8.1	8.316	3.6778
OA	8.06	8.1767	1.3868
Fat in <i>Thabdi Peda</i> (%)	16.6	16.8033	0.5889
Moisture in <i>Thabdi Peda</i> (%)	16.8	17.4800	3.9502
Hardness (N)	544.125	516.258	2.5454
Water activity (a_w)	0.787	0.807	2.6985
FFA (μ eq/g)	0.798	0.759	1.0257
HMF (μ mole/100 g)	116.683	121.917	1.2817

^a Predicted values of Design Expert 8.0.3 package

^b Actual values (average of three trials) of the optimized product

* *t*-values non-significant at 5 % level of significance (Tabulated *t*-value= 4.303)

of the product. Water activity in *Thabdi Peda* ranged from 0.427 to 0.864. The water activity of *Thabdi Peda* influenced significantly and negatively at both linear and quadratic levels

Fig. 3 Schematic diagram of the standardized process for manufacture of *Thabdi Peda*

of duration of heat treatment may be due to the reduction in its moisture content on desiccation, while sugar has the non-significant inverse relationship with water activity in *Thabdi Peda* at linear level. The sugar level also affects it because of binding of water in the product.

Free Fatty Acids (FFA) for *Thabdi Peda* ranged from 0.514 to 2.38 μ eq/g. All the three factors increases the FFA at linear level, but only duration of heating has significant effect. Interaction of fat and sugar was also found to significantly decrease the FFA in *Thabdi Peda*. FFA content of *Thabdi Peda* can be a result of initial fat content in milk, duration of heating and speed of scrapping i.e. the intensity of heat treatment and sugar added due to breaking of fat globule membrane and thus, oozing out of fat. It finally lead to increase in FFA content. Added sugar may be having protective effect on fat globule membrane breakdown, thus decreasing the FFA content in the product. The higher or lower production of FFA in the product is greatly affected by the combined influence of all factors and hence they can be optimized judiciously to have a product with favourable quality attributes.

Heating is an import treatment for concentrated and desiccated milk product like *Thabdi Peda* that the peculiar brown colour, caramelized, and cooked flavour, nutty taste and smooth but grainy texture are solely because of the final stages of its desiccation while manufacture. Final heat treatment and its period for manufacture of *Thabdi Peda* is thus very important for desired characteristics of *Thabdi Peda*. The time of final heat treatment was adjudged on the basis of the final characteristic grainy texture and brown colour development. Hydroxyl Methyl Furfural is the index of browning in dairy products (Walstra and Jenness 1984). All the three factors showed non significance, but they have positive effect on

values of HMF content in *Thabdi Peda*. The maximum effect was of duration of heating followed by rate of sugar addition and fat% in milk on the HMF content of *Thabdi Peda*. It is because of addition of sugar at the time of first boiling which gets more time for the Maillard reaction to occur at higher temperature. Similar observation was made by Rao et al. (2003) while studying Milk Cake; in order to get the desired final concentration they heated concentrated milk with sugar at higher temperatures for longer periods which resulted in browning of the entire product.

Optimization of independent variables

Optimization of the process for the manufacture of *Thabdi Peda* was carried out with the objective of determining the best possible combination(s) of percent fat of milk, percent rate of sugar addition and duration of heating during processing that would lead to the most acceptable product in terms of sensory attributes, compositional, textural and physico-chemical characteristics. The optimum levels suggested by the software Design expert 8.0.3 for Fat % in milk, rate of sugar addition and duration of heating were 6 %, 8.33 % and 34 min with the desirability of 0.955. The predicted and actual response values (obtained after making the product using the optimum level of ingredients) have been presented in Table 4 from which it can be observed that both the values were statistically at par, hence, the above levels of ingredients were recommended. The Schematic Flow Diagram Standardized for the manufacture of *Thabdi Peda* is shown in Fig. 3.

This standardized process yielded standardized *Thabdi Peda* having the proximate composition as depicted in Table 5. The detailed analysis of the compositional, physico-

Table 5 Average proximate chemical composition, physico-chemical, microbiological, rheological and sensory properties of standardized *Thabdi Peda*

Attributes	Value	Attributes	Value
Compositional attributes		Microbiological count ^a	
Moisture (%)	17.48 $\pm$ 0.266	Standard plate count	3.68 $\pm$ 0.122
Fat (%)	16.80 $\pm$ 0.135	Yeast & mold count	2.506 $\pm$ 0.132
Total protein (%)	11.25 $\pm$ 0.073	Coliform count	0
Lactose (%)	20.95 $\pm$ 0.271	Rheological properties	
Sucrose (%)	29.99 $\pm$ 0.211	Stiffness (N/mm)	282.66 $\pm$ 1.527
Ash (%)	3.53 $\pm$ 0.018	Hardness (N)	516.25 $\pm$ 18.961
Yield (%) w/w	28.75 $\pm$ 1.05	Cohesiveness	0.18 $\pm$ 0.015
Physico-chemical attributes		Chewiness (N)	5.545 $\pm$ 0.108
Acidity (% L.A.)	0.347 $\pm$ 0.005	Adhesiveness (N mm)	11.57 $\pm$ 2.848
pH	6.42 $\pm$ 0.015	Fracture force	39.1 $\pm$ 3.305
Water activity (a_w)	0.807 $\pm$ 0.013	Sensory attributes ^b	
Free fatty acid (μ eq/g)	0.759 $\pm$ 0.065	Colour and appearance	8.11 $\pm$ 0.127
Soluble nitrogen (%)	1.02 $\pm$ 0.005	Body and texture	7.97 $\pm$ 0.410
HMF (μ moles/100 g)	113.16 $\pm$ 14.676	Flavour	8.31 $\pm$ 0.104
		Overall acceptability	8.17 $\pm$ 0.145

^a Microbial counts are log transformed values

^b Sensory scores are based on 9-point hedonic scale

chemical, textural, sensory as well microbial attributes obtained from the three replications employing the optimized processing factors was performed and their average values are tabulated here under in Table 5.

Conclusion

It is concluded that all the study parameters such as standardization of fat content of milk, rate of addition of sugar and standardization of the final heat treatment play a significant role in obtaining *Thabdi Peda* with high acceptability and consistent quality. The good quality *Thabdi Peda* could be prepared using milk standardized at 6 % fat and 8.33 % sugar addition at the time of first boiling of milk. The time of final heat treatment was optimum when the heat treatment was given for 34 min. This duration of heat treatment is employed initially for the first half to have pat formation and graininess development, whereas the second half period helped for further moisture removal and colour and grainy texture adjustment.

The current study resulted in the development of a *Thabdi Peda* of highly acceptable quality. The method standardized for the manufacture of *Thabdi Peda* is very simple and can suitably employ for commercial production.

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