International Food Research Journal 22(1): 155-162 (2015)
Journal homepage: *http://www.ifrj.upm.edu.my*

Process standardization, characterization and shelf life studies of *Chhana jalebi* - A traditional Indian milk sweet

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Article history

Received: 21 April 2013
Received in revised form: 17 June 2014
Accepted: 30 July 2014

Keywords

Chhana
Jalebi
Milk
Standardization
Physico-chemical
Traditional sweet
Shelf life
Potassium sorbate
Deep frying
Soaking
Sugar syrup

Abstract

Chhana jalebi is a popular product in middle and northern parts of India and is prepared by frying of batter made from *chhana*, maida and water and finally soaking in sugar syrup. This chhana based fried sweet product is being prepared and sold by halwais in Indian sweet market. It has a coiled structure with syrupy interiors and chewy body. It has close resemblance to maida *jalebi* and *khoa jalebi*, but has firmer coils. The manufacturing procedure varies widely from manufacturer to manufacturer. There was no proper (standard) manufacturing method available for the preparation of *chhana jalebi*. Hence, a study was conducted to standardize a method for its manufacture consequently it will be helpful to produce the *jalebi* on a commercial scale. The *chhana jalebi* was standardized by various process parameters such as fat level in milk 3%, ratio of maida - chhana combination 1:1, water level in batter 45%, frying time and temperature 160-170°C, sugar syrup concentration 68°Brix and soaking time 2 min. Standardized product was analyzed by various physical, chemical, microbial, sensory and textural characteristics. The product had a light brown coloured coiled appearance, crispy body and texture. The nutritional composition percentage of *chhana jalebi* was protein 5.71±0.20, carbohydrate 67.11±0.19, fat 12.53±0.17 and moisture 20.23±0.25. The shelf life of the *jalebi* was found to be 5 days at 28°C. This was enhanced to 18 days by using potassium sorbate as preservative at the permitted levels. The optimized process and enhanced shelf life will pave way for commercialization and mechanization of *chhana jalebi* by food industry.

Introduction

Sweets preparation is an ancient tradition in India and always associated with joyful and celebratory occasions. Indian dairy sweets are ubiquitous part of every festival, wedding, religious ritual and are symbol of pride and happiness. The major portion of milk produced in India is converted into traditional dairy products like *chhana* and khoa which are deep rooted in ancient traditions and have a strong cultural heritage. *Chhana* is a heat-acid coagulated milk product which forms base material for the preparation. *Jalebi* is a popular Indian traditional sweetmeat and the popularity of jalebi can be attributed to its attractive shape, crisp texture and juicy mouth feel (Chakkaravarthi *et al*., 2009a; Balaswamy *et al*., 2012). Jalebi, mouth tempting sweet is prepared by mixing refined wheat flour with water and fermenting this batter with the addition of traditional inoculums (Chakkaravarthi *et al*., 2009a). It is prepared by deep frying a fermented wheat flour batter in pretzel or circular shapes, which are then soaked in sugar syrup (Nivedita *et al*., 2013). The process of jalebi making includes the preparation of a thick batter using refined wheat flour (maida), addition of a small quantity of curd and allowing for fermentation, pouring of the batter in a skilled manner into the hot oil for frying of *jaleb*i strand- embedded structure followed by soaking in sugar syrup (Berry, 1992; Chitale, 2000; Chakkaravarthi *et al*., 2009a; Balaswamy *et al*., 2012). *Chhana jalebi* is one among traditional dairy products and its manufacture not distributed uniformly. However the market of variety of traditional dairy sweets is widespread in India, they have not been commercialized due to predominance of unorganized sector and constraints on their shelf life. This study was undertaken to fulfill the mentioned requirement with the objective of development and characterization of *chhana jalebi* as well as increase the shelf life using permitted preservative.

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Materials and Methods

Milk was procured from the milk parlour of Tamil Nadu University of Veterinary and Animal Science (TANUVAS), Chennai and was standardized to required level of fat and Solid Not Fat (SNF) content. Other raw materials like refined sugar, refined wheat flour (maida) refined sunflower oil, corn flour, cardamom seeds, potassium sorbate, Low Density Poly-Ethylene (LDPE-65 µm film thickness) and metalized polyester (100 µm film thickness) were purchased from the local market.

Preparation of Chhana

Chhana is a heat-acid coagulum prepared from cow milk. It was prepared by following the procedure explained by Aneja *et al*. (2002). The boiled standardized milk cooled to 80°C and citric acid solution (3% strength) was slowly added with slow agitation till greenish clear whey appeared. Then the coagulated mass was allowed to settle and filtered through a muslin cloth. The coagulum obtained called chhana was used for *jalebi* preparation.

Traditional method of chhana jalebi *production*

Preparation of *jalebi* is a traditional method and using the same method *chhana jalebi* was prepared as explained below. Maida and corn flour were thoroughly mixed with required quantity of water into a thick consistency and left for 3 hours for hydration of the contents. Corn flour was used for crispy texture of the product. After hydration, chhana prepared as described above was mixed with vigorous agitation in a mixer to a flowable, but thick consistency. The batter (about 100 g) was filled into a 100 ml capacity flexible plastic bottle and extruded through its narrow opening (4-5 mm diameter) into hot refined sunflower oil in a shallow stainless steel frying pan, with circular movements of hand resulting in formation of coils. However this process requires practice and skill to achieve coils of attractive and regular shape and size. The coils were fried to brown colour, taken out of the hot oil and placed in hot sugar syrup of for 1-2 min. The soaked pieces were taken out of the sugar syrup, drained for a few seconds and used for further studies.

Study parameters for process optimization

Several parameters influence the product quality and result in variations in the product quality. The following are the processing parameters and their levels to study their effect on product quality and optimization: (i) *Chhana* prepared from milk containing: 1.5%, 3%, 4.5% and 6% Milk fat (ii) Water level in the batter: 35%, 40%, 45%, 50% and 55% of total weight of batter (iii) Frying Temperature: 120-130°C, 140-150°C, 160-170°C and 180-200°C (iv) Frying time: 4 min, 3 min, 2 min, 1 min, 50 sec and 40 sec (v) Level of sugar syrup concentration: 50, 60, 63, 65, 68, 70 and 80°Brix [sugar and water ratio:1:1(volume basis); Temperature of sugar syrup: 60°C] (vi) Soaking time in sugar syrup concentration:1, 2 ,3 and 4 min (vii) *Chhana* maida ratio: 15:20, 15:30, 15:40, 15:50, 15:60, 15:70, 30:20, 30:30, 30:40, 30:50, 30:60, 30:70, 45:20, 45:30, 45:40, 45:50, 45:60, 45:70, 60:20, 60:30, 60:40, 60:50, 60:60, 60:70.

Shelf life studies

The *Chhana jalebi* units prepared by the optimized process were packed in LDPE (65 µm film thickness) and metalized polyester pouches (100 µm film thickness) with and without potassium sorbate (permitted preservative, INS No.202) and stored in ambient (28°C) and refrigerator (4°C). The *jalebi* samples were drawn at regular intervals and their quality evaluated by sensory evaluation.

Sensory evaluation

The *jalebi* samples were tempered to ambient temperature and served to panelists in a sensory evaluation room. The panelists were chosen from among the faculties and students based on their interest, ability and availability. They were asked to carefully examine the following attributes of the jalebi samples and award scores on a 9- point Hedonic scale as per their level of liking for: colour, appearance, flavor, body, texture and overall acceptance (Amerine *et al*., 1965).

Textural

The *jalebi* samples were tempered to about 30°C and a portion of coil was placed on the platform of Texture Analyser (Model TA-XT Plus, Stable Microsystems, UK) and the texture profile analysis was carried out as described by Bourne (1978) using p/75 probe. The load settings used for the same were as follows: The probe was calibrated to a distance of 100 mm, above the platform on which sample was to be kept for analysis. The following were the instrument settings at which the above rheological parameters were measured: pre-test speed of probe: 1.0mm/sec; test speed of probe: 0.50 mm/s; post-test speed of probe: 2.0 mm/s; distance by which the probe compressed the sample: 2 mm. A load cell of 5 kg was used and the probe was allowed to compress the sample. The chhana jalebi sample was positioned centrally over the platform and the computer was

allowed to execute the program by activating "run a test" option, then the sample was compressed by the probe up to 2 mm after attaining a trigger force of 5 gm to yield a force - time curve. At this point, the probe returned to its original position, displaying two peaks on the monitor. Seven texture profile parameters were determined from force - time curve. The following parameters were recorded: Hardness (N), Fracturability (N), Cohesiveness, Adhesiveness (N sec), Springiness, Chewiness, Gumminess (David Kilcast, 2013). All measurements were done in quadruplicate.

Color

Color was determined using a hunter lab color flex meter (Hunter Associates Laboratory Inc., Reston, Virgina,USA).Values of lightness (L), redness (a) and yellowness (b) of internal color were measured as per the CIE method (Hutching,1994). For the internal color determination, the chhana jalebi was cut in to half horizontally. The cut surfaces were exposed to the colorimeter. Mean and Standard Deviation (SD) values of four replicates were recorded.

Water activity and pH

The water activity of *chhana jalebi* was determined at 25°C (± 0.2°C) using a digital water activity meter (Aqualab water activity meter, USA). This instrument works based on the principle of dew point. The sample was equilibrated with a head space of a sealed chamber that contained a mirror and a means of detecting condensation on the mirror. For each determination 5 g of sample was used; four replicates were obtained and the average reported; under these conditions reliability of this meter is about ± 0.003 aw.

The pH of *chhana jalebi* was measured using the calibrated digital pH meter (Systronics) at 30°C. The electrode assembly of a digital pH meter was calibrated against standard buffer solution of pH 7.0 and 4.0 (Qualigens Fine Chemicals) before use. About 10 g of *chhana jalebi* sample was taken in a 50 ml beaker and mixed thoroughly with 10 ml of luke warm distilled water, mixed thoroughly and the pH of *chhana jalebi* was measured by inserting the electrode into the slurry and the pH recorded.

Sugar syrup absorption and oil absorption

The absorption of sugar syrup and oil was determined on *chhana jalebi* samples. Oil absorption (%) was calculated on a dry weight basis from difference between the fat contents of *chhana jalebi* and dough. Sugar syrup absorption (%) was calculated on a dry weight basis from difference between before and after soaking into sugar syrup. The thickness of the coil and the size of the *jalebi* coil were measured by using a metallic measuring scale. Brix of sugar syrup was determined using hand held Refractometer ('Erma').

Composition

The *chhana jalebi* units were homogenized by mortar and pestle. The homogenized mixture was used for the compositional analyses. Fat content was determined by Majonnier method (IS: SP: 18, Part XI, 1981), total protein by micro Kjeldahl method (AOAC, 2005) acidity by titration method (IS: SP: 18, Part XI, 1981), moisture by gravimetric method (IS: SP: 18, Part XI, 1981) and ash content by AOAC (2005) procedure. Sucrose was estimated by Lane Eynon method described for sugar estimation in sweetened condensed milk (IS: SP: 18, Part XI, 1981). The carbohydrate content of *chhana jalebi* was calculated by AOAC (2005). The pH of the sample was determined by pH meter.

Microbial counts

Microbiological analysis was carried out as per (IS: SP: 18, Part XI, 1981) procedures for determining the Standard Plate Count (SPC) and yeast & mold counts.

Statistical analysis

The statistical significance of data was analysed by one way and two-way ANOVA by SPSS software Windows version 20.0. Critical difference required for determination of statistical significance between treatments was determined as suggested by Sundararaj *et al*. (1972). The mean differences were calculated using the Tukey test ($P \leq 0.05$). It was possible to perform parametric tests for the percentages because the sample sizes were identical (Peano et al., 2014).

Results and Discussion

Effect of various parameters on the sensory quality of *chhana jalebi*

Fat content of milk

Fat plays a significant role in determining the quality of *chhana*. Increasing of fat level in milk is desirable character for *chhana* making with soft end product. Soft *chhana* is preferable for manufacture of *jalebi*. *Chhana* prepared with milk containing different fat levels was admixed with maida and *jalebi* was prepared from the batter. The mean values of sensory scores of the *jalebi* on 9 point hedonic scale are presented in Table 1. *Jalebi* prepared from

Table 1. Sensory scores of *chhana jalebi* for various attributes

		Color & Appearance	Flavor	Body & Texture	Overall acceptability
Fat level in milk(%)	1.50%	7.31±0.51^{a}	7.08±0.44^{a}	6.6±0.77^{a}	7.11±0.63^{a}
	3.00%	7.33^{a}±0.59^{a}	7.70±0.46^{b}	8.12±0.74^{ab}	7.70±0.62^{d}
	4.50%	7.38 ±0.744^{a}	7.89±0.45^{b}	7.52±0.98^{a}	7.47±0.66^{c}
	6.00%	7.36 ±0.74^{a}	8.19±0.50^{c}	6.71±0.72^{a}	7.28±0.67^{b}
	CD (P=0.05)	NS	0.23	0.98	0.16
Water level in batter (%)	35	7.04±0.26^{a}	7.1±0.29^{a}	6.80±0.14^{a}	6.80±0.14^{a}
	40	7.06±0.19 ^{a}	7.14±0.24 ^{a}	7.06±0.19^{b}	7.06±0.19^{ab}
	45	7.06± 0.19 ^{a}	7.18±0.22 ^{a}	8.24±0.18^{c}	7.24±0.18^{b}
	50	7.06±0.13 ^{a}	7.10±0.28 ^{a}	7.08±0.19^{b}	7.00±0.14^{a}
	55	7.06±0.18 ^{a}	7.12±0.25 ^{a}	6.80±0.20^{a}	6.88±0.17^{a}
	CD (P=0.05)	NS	NS	0.23	0.2
Frying temperatures (°C)	125±5/5min	7.78±0.29^{NS}	6.80±0.57^{a}	6.30±0.44^{a}	6.50±0.50^{a}
	145±5/4 min	7.88±0.16 ^{NS}	7.10±0.72^{ab}	6.95±0.377^{ab}	6.95±0.37^{a}
	165±5/2min	7.98±0.35 ^{NS}	7.70±0.57^{bc}	8.11±0.36^{bc}	8.00±0.58^{b}
	190±10/65sec	7.88±0.13 ^{NS}	6.56±0.84^{a}	6.60±0.54^{a}	6.60±0.54^{a}
	CD (P=0.05)	NS	0.52	0.44	0.5
Sugar syrup concentrations (°Brix)	50	7.75±0.36^{NS}	6.90±0.74^{a}	6.90±0.74^{a}	6.90±0.74^{a}
	60	7.75±0.23^{NS}	7.34±0.55^{a}	7.30±0.44^{a}	7.10±0.74^{a}
	65	7.75±0.31^{NS}	8.17±0.18^{bc}	7.34±0.47^{ab}	7.14±0.77^{a}
	68	7.75±0.23^{NS}	8.70±0.13^{c}	8.12±0.45^{bc}	7.92±0.68^{b}
	70	7.75±0.36^{NS}	7.17±0.74^{ab}	7.50±0.50^{a}	6.90±0.74^{a}
	80	7.75±0.47^{NS}	6.53±0.84^{a}	7.20±0.57^{a}	6.80±0.75^{a}
	CD P=0.05)	NS	0.59	0.4	0.44

Note: Values with different superscripts in a column are differ significantly at P≤0.05; NS-Not significant

1.5%, 3%, 4.5% and 6% of milk fat have given same color development. The color of jalebi varied from light yellow to brown; however, fat level in milk did not show any impact on color and appearance scores since frying time and temperature plays vital role on the same. Brown colour development during frying is attributed to derivatives of proteins and their interaction with carbohydrates (Van Boekel, 1998). 1.5%, 3%, 4.5% and 6% milk fat contributes less, optimal, strong and very strong flavors to the products respectively. The flavor of *chhana jalebi* was partly dependent on fat level in milk as indicated by significantly higher flavor scores (P<0.05). This could be attributed to the optimal fatty acid balances in butter fat. Milk fat contributes to desirable flavor of milk Webb and Johnson (1965). The body and texture of the product was also influenced by fat level in milk. The *jalebi* became firmer to more chewy as fat level in the milk increased. The fat generally contributes to the soft texture to the product; but in the present study the product prepared with higher fat milk exhibited chewy body. This may be attributed to interaction of proteins and fats during frying at high temperature (Marmesat *et al*., 2005). According to the panel of evaluators, flavor of the product was better for 6% milk fat product, overall score was less due to more chewy body and texture. Finally, desirable color, flavor and body and textured *jalebi* was obtained from 3% fat milk (Table 1).

Water content of batter

Water plays a key role in food preparation. It helps to distribute the particles like starch and protein to produce a smooth texture. The quantity of water in food creates impact on texture, consistency and makes comfortable feeling in mouth during chewing process. In case of *jalebi* manufacture, water level in batter is very important because it affects the integrity of coils formed for deep fat frying. The mean values of sensory scores obtained from 9 point hedonic scale are presented in Table 1. There was no impact of water level in batter on color, appearance and flavor of the product, but the body and texture of the product was highly dependent on water levels in the batter. During studies 35%, 40%, 45%, 50% and 55% levels of water in weight basis added in to the batter. *Jalebi* samples were shown very hard, hard, crispy, very firm and soggy texture based on the water content in batter. Product became firm and soggy as water content increased in the batter. This is attributed to gelation and water absorption during batter making. The crust thickness of the product increased with respect to decreasing moisture content during frying. The sensory score of body and texture of product prepared from 35% to 45% moisture batter ranged from 6.80 to 8.24, whereas further increase of water level in batter to 50% and 55% decreased scores to 7.08 and 6.80 respectively, which was statistically significant (P≤0.05). This was due to interaction of water and protein during frying (Van Boekel, 1998). In case of *khoa jalebi*, 45% moisture in batter was recommended (Ketan, 2012), whereas in maida jalebi, 57-61% water level was used for obtaining good quality final product (Chakkaravarthi *et al*., 2009b).

Frying temperature

Frying temperature determines the nature of the fried product, especially in deep fat fried foods. Foods fried at the optimum temperature and time which have golden brown color, crispy and optimal

Table 2. Quality characteristics of *chhana jalebi* prepared by standardized method

Quality characteristics	Mean value with SD	Quality characteristics	Mean value with SD
Physical characteristics		Chemical characteristics (%)	
Weight of jalebi, g	5.1±0.22	Moisture	20.23±0.25
Thickness of jalebi, cm	0.81±0.09	Fat	12.53±0.17
Diameter of jalebi, cm	6.51±0.48	Protein	5.71±0.202
Sugar syrup absorbed by each jalebi (g)	2.77±0.20	Sucrose	40.21±0.30
Oil absorbed by each jalebi (g)	1.57±0.04	Ash	0.29±0.06
pH	5.05±0.07	Carbohydrate	67.11±0.19
Acidity (% of lactic acid)	0.310±0.01	Water activity	0.825±0.002
Sensory characteristics (9-Point scale)		Textural characteristics	
Colour and appearance	7.83±0.16	Hardness (N)	0.028±0.003
Flavour	8.42±0.16	Fracturability (N)	1.38±0.584
Body and Texture	8.26±0.34	Cohesiveness	0.438±0.109
Overall acceptability	8.41±0.23	Adhesiveness (N s)	-0.012±0.008
Color characteristics		Springiness	0.694±0.101
L*	51.04±1.47	Chewiness	0.008±0.003
a*	10.35±0.29	Gumminess	15.82±1.416
b*	29.97±2.66	Microbial characteristics	
		SPC (cfu/g)	$7x10^2$
		Yeast and mould (cfu/g)	$6x10^2$

oil absorption (Blumenthal, 1991). However, under fried foods at lower temperature or shorter frying time have white or slightly brown color at the edge, and have un-gelatinized or partially cooked starch at the center. Over fried foods at higher temperature and longer frying time have darkened and hardened surfaces and a greasy texture due to the excessive oil absorption (Choe and Min, 2007). The mean values of sensory scores are presented in Table 1. Color and flavor changes in product were due to increased rate of non-enzymatic browning (Maillard) reactions between proteins and reducing sugars during frying (Van Boekel, 1998). Higher temperature gave dark brown color and cooked flavor to the product; similarly lower frying temperatures resulted in whiter color. During deep-fat frying the food is completely surrounded by the frying fat or oil and different events occur within a few minutes: dehydration of food surface, absorption of fat, formation of flavor compounds, development of surface color, etc (Dobarganes *et al.*, 2000). The texture of product is influenced by the type of oil used, frying temperature and time. Crispiness is an important textural characteristic of fried foods. Crispiness indicates freshness and high quality (Szczesniak, 1988). For example, a crisp fried food should be firm and should snap easily when deformed, emitting a crunchy sound (Christensen and Vickers, 1981). Same case was observed in *chhana jalebi* fried at 160-170°C. Lower temperature (120-130°C for 4-5 min and 140-150°C for 3-4 min) of frying resulted in chewy texture, more oil absorption, hard surface and higher frying temperature (180-200°C for 40-50s) resulted in case hardening. The optimal temperature of frying i.e. 160-170°C for 1-2 min gave crispy texture, light golden color and pleasant flavor.

Sugar syrup concentration

Sugar syrup concentration not only provides taste and optimal sweetness of the product but also has an influence on soaking characteristics of sugar syrup, shelf life and commercial value. In addition, effective soaking depends on temperature of syrup and soaking time. Color and appearance of *chhana jalebi* was not dependent on sugar syrup concentration as indicated by colour and appearance scores presented in Table 1 which were not statistically significant (P>0.05). Both increasing and decreasing of sugar syrup concentrations resulted in less acceptable taste of the *jalebi.* The temperature of sugar syrup concentration was maintained as constant at 60°C. The lower sugar syrup concentration of 50°Brix, 60°Brix and 65°Brix for 2 min gave soggy texture, whereas the product prepared with higher sugar syrup concentration of 70°Brix and 80°Brix for 2 min resulted in firmer body. The sugar syrup concentration of 68°Brix for 2 min gave optimal sweetness, desirable sugar syrup absorption, crispiness and more juiciness. The sugar syrup concentration of 50, 60, 65, 68, 70, 80°Brix for 1 min shown poor sugar syrup absorption whereas *jalebi* samples of same concentration for 3 and 4 min, resulted high sugar syrup absorption, sweetness and soggy body and texture.

Chhana - *maida combination*

Maida plays a vital role in chhana jalebi making by acting as binding agent. The binding agents affect the composition, rheology and sensory attributes of the product. Addition of maida and chhana ratio of 1:1 ratio resulted in best quality product with crispy body and uniform texture. Addition of lower quantity maida and higher quantity of *chhana* produced a product which was more brittle and coil disintegration during frying. Higher quantity maida and lower quantity of *chhana* resulted chewy and

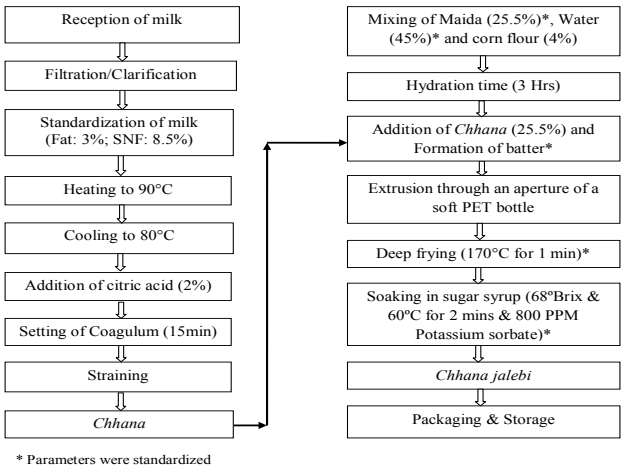

Figure 1. Flow chart of standardized method of *chhana jalebi* preparation

more firm product. It also influenced syrup holding capacity of fried dough along with its ingredients during soaking process. Increase of maida levels from 20 g to 70 g showed significant difference in scores and increase of chhana levels from 15 g to 60 g had also showed significant difference in them. It may be observed that all the combinations of *chhana*-maida ratio had significant influence on overall acceptance of the product. The statistical analysis revealed the same ($P \leq 0.05$). Maida is a common binding agent used in dairy products like *gulab jamun* (Londhe *et al.*, 2000), *chhana podo* (Ghosh *et al*., 2007) and *pantoa* (Pandya and Khan, 2006) in which it helps in obtaining the typical shape and texture for which the products are well known.

Optimized process of chhana jalebi *production*

Chhana jalebi was manufactured based on the optimized specifications of individual processing parameters. The flow chart is provided in Figure 1. The optimized process includes preparation of *chhana* from 3% fat level milk, mixing of chhana with hydrated maida, corn flour and water to form a smooth and uniform consistency batter. The well kneaded batter was extruded through an aperture of soft PET bottle to give a coiled shape. Extruded batter coils were fried in hot refined sunflower oil for deep frying at 160-170°C till surface color became light golden to yellowish golden color. The fried products were then soaked in warm sugar syrup for 2 min. Then the soaked *jalebi* coils were drained out of sugar syrup and packaged in packaging material.

Physico-chemical characteristics of chhana jalebi

After the production of optimized *chhana jalebi* it was analyzed for various physical characteristics such as weight, thickness, diameter, absorption, pH, acidity; textural characteristics such as hardness, fracturability, cohesiveness, adhesiveness, springiness, chewiness, gumminess; sensory characteristics such as color and appearance, flavor, body and texture, overall acceptability; color characteristics and chemical characteristics such as moisture, fat, protein, carbohydrates, sucrose, ash and water activity etc. The mean values of mentioned characteristics are given in Table 2. Based on the results, it was concluded that the standardized *chhana jalebi* samples were golden yellow in color and coil shaped, crispy with porous core, slightly juicy with syrup oozing out when chewed, having high protein and fat content, and fracturability that is brittle in nature. Hunter Color Lab results revealed that degree of lightness (i.e., L value) decreased with increase of storage period (Paul Sanjib Kumar et al., 2014). The overall acceptability score was above 8, which indicates that the product was 'liked very much' and highly acceptable (Paul *et al.*, 2014).

Microbial characteristics of standardized chhana jalebi

The *chhana jalebi* had a Standard Plate Count of $7x10^2$ cfu per g and yeast and mold count of $6x10^2$ cfu per g (Table 2). Presently there is no microbiological standard for the products like *jalebi*; however for *chhana* (material used for *chhana jalebi* preparation) standards are available (FSSAI, 2006). In this regard, the results obtained in this study may be helpful for the formulating microbiological standards for the *jalebi* in future.

Storage studies of chhana jalebi

Chhana jalebi was manufactured based on optimized process as shown in Figure 1. It was observed that *Chhana jalebi* packed in LDPE pouch without preservative could stay in good condition and quality up to 5 days at room temperature (28°±2°C), whereas it could be stored up to 15 days at refrigerated temperature (4±2°C). In order to enhance the shelf life, a commonly used permitted class II preservative viz. potassium sorbate was used, which was dissolved in soaking syrup at a concentration of 800 ppm. This concentration is well below the permitted levels of the preservative in milk based sweets i.e. 1000 ppm (FSSAI, 2006). It acts against bacteria, yeasts and molds by alteration of cell membranes, inhibition of transport systems and key enzymes, creation of a proton flux into the cell, or more than one of these actions (Sofos *et al.*, 1986).

Chhana jalebi was prepared with and without the preservative and packed in two packaging materials viz. LDPE (low barrier) and metalized polyester (high barrier). The packages containing the *jalebi* were stored at 28°C and 4°C. Samples of jalebi were

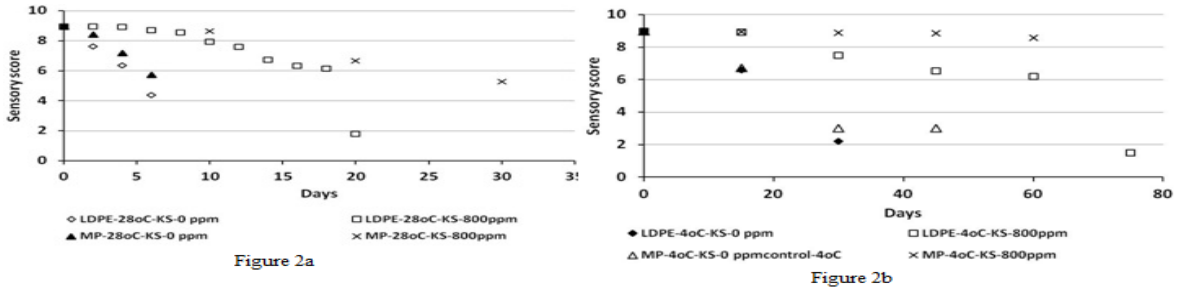

Figure 2a

Figure 2b

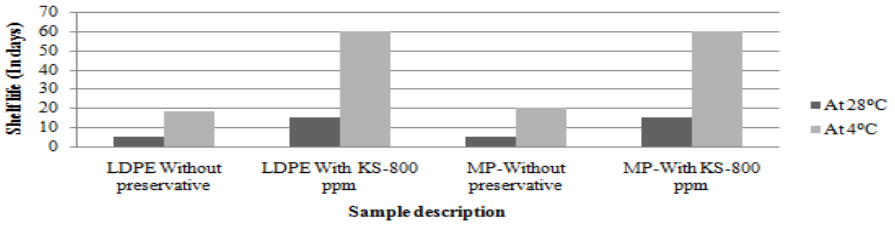

Figure 2c

Figure 2a and 2b. Changes in sensory score (overall acceptance) of *chhana jalebi* during storage at 28°C and 4°C; Figure 2c. Shelf life in days of *chhana jalebi*

drawn at regular intervals and analysed for changes in sensory quality. This study was conducted till the product spoiled, which was determined based on sensory acceptance. The sensory acceptance score slowly declined as the storage period progressed both at 28°C and 4°C due to the changes in the physico-chemical characteristic of the product and pattern of decline is represented in Figure 2a and 2b. The *jalebi* gradually became dry and developed off flavour. Presence of preservative slowed down the changes, enhancing the shelf life at both the storage temperatures employed (Figure 2a and 2b). The changes occurred faster in product without preservative. Potassium sorbate with 800 ppm of concentration was found as suitable preservative for the preservation of *chhana jalebi*. The shelf life of chhana jalebi was enhanced to 18 days (20 days in case of metalized polyester) at ambient temperature and 60 days shelf life at refrigerated conditions irrespective of the type of packaging material used. The shelf life of *chhana jalebi* is diagrammatically represented in Figure 2c. It was reported that scientists successfully employed the potassium sorbate for preserving the *khoa jalebi* up to 15 and 25 days at 30°C with a concentration of 500 ppm and 1000 ppm, respectively (Bharat and Pagote, 2012). Potassium sorbate was also found to enhance the shelf life of another milk product, khoa (Ghodekar *et al*., 1978).

Conclusion

Chhana jalebi production process was standardized with optimal specifications of raw materials which include 3% milk fat chhana, 1:1 ratio of maida - chhana combination, 45% of water level in batter, 160-170°C frying temperature for 2 min and 68°Brix sugar syrup concentration for 2 min soaking time. Mass of individual *jalebi* was 0.519N. Shelf life of the product achieved was 18 days at room temperature and 60 days in refrigerated condition by using potassium sorbate as preservative. The outcome of the research is useful to industry for commercialization of *chhana jalebi* with the application of traditional knowledge.

Acknowledgements

The authors thank Dr. R.Visvanathan, Professor and Head, Post-Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore and Dr. Ashish Kumar Singh, Senior Scientist, National Dairy Research Institute, Karnal, India, for providing instrumentation facilities.

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