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Preparation, processing and sensory evaluation of steamed sweetened Channa – An innovative study in Food Science

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ABSTRACT

Chhana is one of the popular traditional Indian dairy product. It is high in nutritive value, consumed by people of different age group almost in every house. Chhana is mainly used as base ingredients for manufacturing of sweetmeats, specially in eastern region of India. To increase the palatability of chhana, an attempt was taken to develop a product-steamed sweetened chhana by adding sugar into chhana and steaming the mixture. On the basis of preliminary trial level of sugar was selected in the range of 27% to 33% of the weight of chhana and the steaming time for channa mixed with sugar was selected in the range of 40 min - 80 min. A comparative study was carried out to evaluate the effect of different concentration of sugar (i.e. 27%, 30%, and 33%) in each steaming condition (i.e. 40 min, 60 min and 80 min) and the effect of different steaming time (i.e. 40 min, 60 min and 80 min) in each sugar concentration (i.e. 27%, 30%, and 33%) on the sensorial as well as physico chemical quality of steamed sweetened chhana. Based on sensorial scores for different attributes viz. flavour, body and texture, colour and appearance, and overall acceptability the addition of sugar at the rate of 30% of the weight of chhana and steaming for 60 min was selected as optimum for preparing steamed sweetened chhana of acceptable quality. The optimized product contained 36.74% moisture, 16.80% fat, 15.84% protein, 1.88% ash and 28.74% total carbohydrate. The titratable acidity of optimized protein was 0.546% lactic acid. The shelf life study was carried out by packaging the product in 3-ply laminated (polyethylene/aluminum foil/polyethylene) pouch and keeping at 8±2°C. The sensorial

quality and chemical quality deteriorated with progression of storage. The shelf life of steamed sweetened chhana was estimated as 9 day at 8±2°C.

Keywords: Channa, steamed dahi, bhapasandesh, coagulam, aluminium foil, nutritive value.

INTRODUCTION

India is the largest milk producer in the world with an annual production of 176.3 million tonnes and a per capita availability of 375 g/d [1]. About 50% of milk produced in India is converted into traditional milk products [2]. The Traditional Indian Dairy Products (TIDP) like paneer, chhana and chhana based sweets, khoa and khoa based sweets, desserts etc. are deep rooted in ancient traditions and have a strong cultural heritage. The TIDP have earned immense popularity for their social, economic, religious, medicinal, and cultural significance. Chhana is the heat and acid coagulated curd obtained by the direct acidification of heated milk with dilute organic acid followed by the removal of whey by filtration. It contains 51.7–53.4% moisture, 14.4–17.4% protein, 24.4–29.7% fat, 2.2–2.3% lactose and 1.9– 2.1% ash [3]. As per FSSR [4] ("chhana is the product obtained from any variant of milk, with or without added milk solids by precipitation with permitted acidulants (lactic acid, citric acid, malic acid, vinegar, glucono delta lactone, sour whey) and heating. The product should contain not less than 50% milk fat on dry matter basis and not more than 65% moisture." Chhana is popular among people of all age groups because of its high nutritive value and palatability. It is used as a base material for several Indian sweetmeats like rasogolla, sandesh, chum-chum, chhana murki, chhana podo, rasomalai, chhana balushahi, khorma/belgrami, pantowa etc. Pattern of milk consumption in India indicates that about 6% milk is converted into chhana[5]. Researchers and sweet manufacturers have a variety of TIDP by steaming the ingredients. Popular steamed products in eastern region include bhapadai (steamed dahi), chittaranjan (bhapasandesh) etc. In view of the popularity and market potential of steamed products an attempt was made to develop steamed sweetened chhana.

REVIEW OF LITERATURE

Chhana is one of the most important traditional Indian dairy products. Chhana is a heat and acid coagulated milk product. Being rich in milk nutrients, chhana is preferred as daily diet by most of the people, especially by lactose intolerant people. Chhana is also used as the basic ingredients for preparing several traditional sweetmeats such as rasogolla, sandesh, chhanapodo, rasmalai etc. The present review presents a broad range of research on chhana, its quality, nutritive value, shelf life and some chhana based products.

Factors influencing the quality of chhana

The quality of chhana depends largely on type and composition of milk. The other factors responsible for quality characteristics of chhana are type and strength of coagulant, processing parameters like coagulation temperature, coagulation pH, whey drainage

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procedure etc.

Type of Milk

Cow milk chhana is preferred over buffalo milk chhana for sweet preparation as cow milk chhana has soft body and smooth texture, while buffalo milk chhana which has hard body and greasy texture. Aminimum fat level of 4 per cent in cow milk and 5 percent in buffalo milk is preferred for the production of good quality chhana [6].It was reported that low fat milk resulted in a hard body and coarse texture in chhana. On the other hand, higher fat level increased greasiness and stickiness in chhana sweets. De reported that high acidic milk contributed to sour and bitter flavour to chhana. The addition of neutralizer to acidic milk however helps in obtaining chhana which can be satisfactorily used for making sandesh of an acceptable quality. The adulteration of milk with starchresulted in a gelatinous mass on coagulation, which is undesirable forsweetmaking [7]. The mixing of colostrum in milk produced a weakbody and pasty texture in the coagulated mass [8]. Baisya andBose [9] observed a positive correlation between calcium content of milk and hardness of curd. De and Ray 10] suggested dilution of buffalo milk with 75% cow milk for obtaining desired quality chhana. The addition of sodium citrate into milk and dilution of buffalo milk with 20-30% water were used as suggestive measures for preparing satisfactory quality buffalo milk chhana [11]. Sindhu et al [12] reported about the effect of salt balance (ratio of calcium and magnesium to citrate and phosphate) on texture of chhana.

OBJECTIVES

The present work was undertaken with the following objectives: 1. To optimize the processing parameters for developing steamed sweetened chhana. 2. To evaluate the shelf life of the optimized steamed sweetened chhana.

MATERIALS AND METHODS

Raw materials namely cow milk, sugar, cardamom etc. were used to make steamed sweetened chhana are discussed here and have focuses on experimental methodologies, procedures and techniques adapted in the present investigation.

I. Selection of ingredients:

Selection of good quality ingredients is the most important factor for successful investigation. Hence, good quality raw materials were selected for use in the present investigation.

i) Cow Milk

Fresh, raw cow milk was collected from the cattle herd under the West Bengal University of Animal and Fishery Sciences, Mohanpur, Nadia, West Bengal. Gir breed cow of three years old was chosen for milk collection. The cow was fed with general fodder like grass, straw, green leaf, pulse (gram bean or chickpea) and often allowed for grazing within the sub-field.

Sometimes, commercial nutrient substitutes were also added to the fodder for health issues of the animal. Milk was standardized to 4% fat and 8.5% solids not fat.

ii) Table sugar

Normal Edible common white table sugar was procured from the local market at Shyamnagar (North 24 PGS, West Bengal, India). It meets the standard of at least 99.8% pure sucrose and provides 4 calories of energy per g.

iii) Cardamom

Cardamom was taken from local market of Shyamnagar (North 24 parganas, West Bengal, India).It was used as the flavoring agent in the product.

iv) Packaging material

Food grade 3-ply laminated film of polyethylene/aluminium foil/polyethylene (PE/Al foil/PE) (thickness 80 μ) procured from the Baithak-khana market at Kolkata (West Bengal, India) were used as packaging materials for packaging of ghee residue based snack during storage studies.

v) Chemical reagents

All analytical grade reagents were used in the analysis of the products.

II. Method of preparation of steamed sweetened chhana:

To prepare steamed sweetened chhana, cow milk was first standardized to 4% fat and 8.5% SNF. The standardized cow milk was heated to 90°C and hold at this temperature for 10 min. Thereafter the milk was cooled to 82°C. The citric acid solution of 2% strength was prepared and heated to 82°C. The milk was then coagulated by citric acid solution at 82°C. After completion of coagulation it was kept undisturbed for 5 min. The coagulum was then collected by draining whey through muslin cloth. Ground sugar was added with the chhana at rate of 27%, 30% and 33% of the weight of chhana. The chhana was kneaded with ground sugar. Cardamom powder was mixed with kneaded chhana at the rate of 0.5% of the weight of chhana. The kneaded chhana was then kept into a closed stainless steel container for steaming. It was steamed for 40 min, 60 min and 80 min for each sample of chhana with different sugar content. The steamed sweetened chhana was then cooled to room temperature, packaged in 3ply laminated(polyethylene/aluminium foil/polyethylene) pouch and stored at 8±2°C.

III. Analytical methods:

In the preparation of steamed sweetened chhana, the quality of the product has been assessed by sensorial, physico-chemical analysis. The methodologies followed in technological and analytical aspects are mentioned hereunder.

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i) Sensory evaluation

The steamed sweetened chhana samples were evaluated by a panel of trained judges selected from the Faculty of Dairy Technology, WBUAFS, Mohanpur (Mohanpur 16 Campus, Nadia, Kolkata, West Bengal) for sensory characteristics through 9-point hedonic scale sensory score card supplemented with scoring guide. The sensory attributes included flavor, body and texture, color and appearance and overall acceptability (Annexure: I). The sensory evaluation was carried out in individual booth illuminated with white light and the samples (each sample at 15±2°C) were presented in random order coded with digital numbers to eliminate the carry over effect. The panelist provided independent observations on a maximum of three randomized samples at a time.

ii)Analysis of milk

a)Fat and Solids not fat

Gerber method as described in IS:SP:18 ([13].

b) Physico-chemical analysis of steamed sweetened chhana

c) Estimation of total solids

gravimetric method (AOAC,) [14].

d) Total ash estimation

IS:SP:18 (Part XI) [13].

e) Total fat content estimation

RoseGottlieb method as described in IS: SP: 18 [13].

f)pH

AOAC official method [14].

g) Titrable acidity

Titrametric method as described by AOAC official method [14].

h) Estimation of total protein

AOAC official method [14] and multiplying the total nitrogen content with the factor of 6.38.

i)Tyrosine value analysis

Juffs [15].

j) Standard curve for tyrosine

Estimation of thiobarbituric Acid (TBA) value

King [16]

k) Estimation of free fatty acid (FFA)

Deeth and Fitz-Gerald [17]

IV) Statistical analysis

The significance of the effect of different processing parameters on the sensorial and physico-chemical quality were assessed by analysis of variance (ANOVA) using IBM SPSS Statistics 20

software package. The significant difference among different samples was compared using Duncan Post Hoc test.

RESULTS AND DISCUSSION

I. Prologue

The present research work was carried out with an aim of developing steamed sweetened chhana from cow milk with acceptable quality. The results obtained during evaluation of the effect of different processing parameters on the sensorial and physico-chemical quality are presented and discussed in this chapter. In addition the shelf life study was carried out and the results were discussed.

II. Optimization of manufacturing procedure of steamed sweetened chhana

For developing steamed sweetened chhana from cow milk chhana, concentration of added sugar and steaming time were selected as processing variables and their range were selected on the basis of preliminary trials. The product was prepared using different concentration of sugar (27, 30, 33% weight of chhana) and different steaming time (40, 60 and 80 min).

III. Effect of different sugar concentration and steaming time on sensorial quality of steamed sweetened chhana

The average scores for various sensory attributes of steamed sweetened chhana prepared using different concentration of sugar (27,30,33%) and different steaming time (40,60and80 min) are represented in the Table 1.

IV. Effect of different sugar concentration and steaming time on flavor score of steamed sweetened chhana

The effect of different concentration of sugar and steaming time on the flavor score of steam sweetened chhana is depicted in the Table 1. The highest flavor score was obtained when the product was prepared by mixing sugar at the rate of 30% of the weight of chhana and steamed for 60 min. When the sweetened chhana was steamed for 40 min, the flavour score of steamed sweetened chhana prepared by using 30% (w/w) sugar was differed non significantly ($p>0.05$) from the steamed sweetened chhana prepared using 27% and 33% sugar. Similarly, when the sweetened chhana was steamed 26 for 80 min, the flavour score of steamed sweetened chhana prepared by using 30% sugar was differed non significantly ($p>0.05$) from the steamed sweetened chhana prepared using 27% and 33% sugar. In case of 60 min of steaming time the flavor score of steamed sweetened chhana prepared by using 30% sugar was differed significantly (p value, 0.05) in flavor score was observed with the variation of steaming time. Similarly, when 33% sugar was added into the chhana, non-significant difference ($p>0.05$) in flavor score was observed with the variation of steaming time. The flavor score was reduced with decreasing sugar concentration might be due to the low sweetness. The flavor score further reduced with increasing sugar concentration after a certain level might be due to the low

desirability of high sweetness. The similar explanation was given by kumar et al. [18]. Kumar et al.]18], during preparation of chhana podo, observed that 35% sugar of the weight of chhana resulted in optimum flavor score as compared to 33% or 37% sugar of the weight of chhana. The baking of chhana podo at 200±5°C for 50 min gave highest flavor score as compared to the baking time of 40 min and 60 min (Kumar et al.) [18]. The result of present study was also in agreement with the study of Bera [19]. Bera [19] prepared malancha by cooking paneer in 50, 60 and 70% sugar syrup for 10, 15 and 20 min. Lower flavor scores for 50 and 70% sugar syrup concentration than 60% sugar syrup concentration were obtained for each steaming time. Bera [19] also observed lower flavor score when cooked for 10 and 20 min as compared to the malancha prepared by cooking for 15 min for each sugar concentration. Similar type of result was also obtained by Kumar[20] who prepared chittaranjen (bhapasandesh) using three levels of sugar i.e. 8%, 10% and 12%. It was observed that chittaranjan with 10% sugar level gave highest flavor score. It was 27 also reported that steaming for 10 min gave satisfactory quality of bhapasandesh as compared to the products steamed for 5 min or 15 min.

V) Effect of different sugar concentration and steaming time on color and appearance score of steamed sweetened chhana

The effect of different concentration of sugar and steaming time on the color and appearance score of steamed sweetened chhana is depicted in the Table 1. The highest color and appearance score was obtained when the product was prepared by mixing sugar at the rate of 30% of the weight of chhana and steamed for 60 mi. When the sweetened chhana was steamed for 40 min, the color and appearance score of steamed sweetened chhana prepared by using 30% sugar was differed non significantly ($p>0.05$) from the steamed sweetened chhana prepared using 27% and 33% sugar. Similarly, when the sweetened chhana was steamed for 60 min, the color and appearance score of steamed sweetened chhana prepared by using 30% sugar was differed non significantly ($p>0.05$) from the steamed sweetened chhana prepared using 27% and 33% sugar. When the sweetened chhana was steamed for 80 min, the color and appearance score of steamed sweetened chhana prepared by using 30% sugar differed significantly ($p<0.05$) from the steamed sweetened chhana prepared by steaming for 40 and 60 min.

Table 1. Effect of different sugar concentration and steaming time on sensorial quality of steamed sweetened chhana

Sensorial Attribute	Sugar (%)	Steaming time (min)		
		40	60	80
Flavour score	27	6.79 ± 0.10^{aA}	6.93 ± 0.3^{aB}	6.57 ± 0.23^{aA}
	30	7.07 ± 0.23^{bA}	7.93 ± 0.17^{aA}	6.57 ± 0.17^{bA}
	33	6.57 ± 0.23^{aA}	6.64 ± 0.18^{aB}	6.43 ± 0.17^{aA}

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Body and texture score	27	7.50 ± 0.15^{bA}	8.29 ± 0.101^{aA}	$7.00\pm.154^{cA}$
	30	7.64 ± 0.21^{bA}	8.36 ± 0.092^{aA}	7.14 ± 0.210^{bA}
	33	7.43 ± 0.17^{bA}	8.14 ± 0.092^{aA}	6.93 ± 0.170^{cA}
Colour and appearance score	27	7.36 ± 0.143^{bA}	7.86 ± 0.143^{aA}	6.93 ± 0.130^{cAB}
	30	7.57 ± 0.130^{bA}	8.07 ± 0130^{aA}	7.29 ± 0.149^{bA}
	33	7.57 ± 0.202^{aA}	7.79 ± 0.214^{aA}	6.50 ± 0.154^{bB}
Overall acceptability score	27	7.14 ± 0.092^{bA}	7.93 ± 0.020^{aAB}	6.789 ± 0.101^{bA}
	30	7.57 ± 0.170^{bA}	8.21 ± 0.101^{aA}	7.00 ± 0.109^{cA}
	33	7.21 ± 0.214^{abA}	7.57 ± 0.130^{aB}	6.71 ± 0.149^{bA}

a,b, c... different superscript in a row (i.e. at constant sugar concentration different steaming time) denotes $p<0.05$.

A, B... different superscript in a column (i.e. at constant seaming time different sugar concentration) denotes $p<0.05$.

VI) Effect of different sugar concentration and steaming time on physico-chemical characteristics of steamed sweetened chhana

The average scores for various physicochemical attributes of steamed sweetened chhana prepared using different concentration of sugar (27,30,33%) and different steaming time (40,60 and 80 min) are represented in the Table 2.

VII) Effect of different sugar concentration and steaming time on fat content of steamed sweetened chhana

The effect of different concentration of sugar and steaming time on the fat content of steam sweetened chhana is depicted in the Table 2. The product prepared by mixing sugar at the rate of 27% of the weight of chhana and steamed for 80 min, contained highest amount of fat i.e. 22.27%. When the sweetened chhana was steamed for 40 min, the fat content of steamed sweetened chhana was decreased significantly ($p>0.05$) with increase in sugar content (i.e. from 27% to 33% sugar of the weight of chhana). When the steamed sweetened chhana was prepared by mixing sugar into chhana at the rate of 27% of the weight of chhana, the fat content of steamed sweetened chhana was decreased significantly ($p<0.05$) with decrease in steaming time (i.e. from 80 min to 40 min). A similar phenomenon was observed when 30% and 33% sugar of the weight chhana were used.

Table 2. Effect of different sugar concentration and steaming time on chemical characteristics of steamed sweetened chhana

Chemical	Sugar%	Steaming time(min)

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characteristics		40	60	80
Fat (%)	27	18.02 ± 0.35^{cA}	20.04 ± 0.10^{bA}	22.27 ± 0.18^{aA}
	30	13.75 ± 0.14^{cB}	16.80 ± 0.05^{bB}	18.46 ± 0.02^{aB}
	33	10.80 ± 0.15^{cC}	13.53 ± 0.52^{bC}	15.38 ± 0.09^{aC}
Moisture (%)	27	43.12 ± 0.05^{aA}	36.79 ± 0.02^{bA}	35.97 ± 0.03^{cA}
	30	42.14 ± 0.09^{aB}	36.74 ± 0.03^{bA}	35.95 ± 0.05^{cA}
	33	41.97 ± 0.06^{aB}	36.00 ± 0.04^{bB}	35.80 ± 0.01^{cB}
Protein (%)	27	14.51 ± 0.04^{bC}	15.48 ± 0.27^{aA}	15.66 ± 0.38^{aA}
	30	14.92 ± 0.40^{cB}	15.84 ± 0.22^{bA}	16.32 ± 0.60^{aA}
	33	15.26 ± 0.40^{bA}	15.94 ± 0.35^{abA}	16.39 ± 0.90^{aA}
Total carbohydrate (%)	27	22.53 ± 0.41^{cC}	24.21 ± 0.58^{bC}	25.83 ± 0.36^{aC}
	30	27.36 ± 0.13^{bB}	27.38 ± 0.30^{bB}	28.74 ± 0.20^{aB}
	33	30.13 ± 0.15^{bA}	30.53 ± 0.18^{bA}	32.63 ± 0.27^{aA}
Ash (%)	27	1.82 ± 0.10^{aA}	1.85 ± 0.30^{aA}	1.88 ± 0.10^{aA}
	30	1.83 ± 0.10^{aA}	1.88 ± 0.20^{aA}	1.89 ± 0.10^{aA}
	33	1.83 ± 0.20^{aA}	1.89 ± 0.70^{aA}	1.89 ± 0.30^{aA}
Titratable acidity (% lactic acid)	27	0.50 ± 0.00^{bA}	0.509 ± 0.01^{bA}	0.574 ± 0.01^{aA}
	30	0.509 ± 0.01^{bA}	0.546 ± 0.01^{aA}	0.574 ± 0.01^{aA}
	33	0.500 ± 0.00^{cA}	0.537 ± 0.19^{bA}	0.586 ± 0.01^{aA}

a,b, c... different superscript in a row (i.e. at constant sugar concentration different steaming time) denotes $p<0.05$.

A, B... different superscript in a column (i.e. at constant seaming time different sugar concentration) denotes $p<0.05$.

VIII) Shelf life study of steamed sweetened chhana stored at 8±2°C

The shelf life of steamed sweetened chhan at 8±2°C was evaluated after packaging the samples in3 Plylaminated (PE /Al foil / PE) pouch.

IX) Sensorial changes in steamed sweetened chhana during storage at 8±2°C

The flavor score of the products decreased significantly ($p<0.05$) upto 5th day of storage (Table 3). The flavour score of the product was reduced from 8.64 at 40 1 st day of storage to 6.50 at 9th day of storage. The higher lactic acid concentration, proteolysis, production of free fatty acids

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through lipolysis as well as oxidation of fat affected the flavour of steamed sweetened chhana adversely. The body and texture score of the product decreased significantly ($p<.05$) with progression of storage (Table 3). The body and texture score of the product was 8.25 at 1 st day of storage, while at 9th day of storage it was 6.21. The decrease in moisture content, the occurrence of lipolysis, lipid and protein oxidation, protein degradation might affect the body and texture of product during storage.

The overall acceptability of the product decreased significantly ($p<0.05$) with progression of storage (i.e. from 8.39 to 6.61) (Table 5.3, Fig. 5.14) owing to the deterioration of flavour, body and texture as well as colour and appearance. The reduction of sensorial score for chhana podo with progression of storage at 6±1°C was observed by kumar et al. [18]. Similar finding was also reported by Kumar[20] and Bera[19] during storage of bhapasandesh and malancha, respectively at 7±1°C.

Table 3. Sensorial changes in steamed sweetened chhana during storage at 8±2°C

Parameters	Storage Day				
	1st	3rd	5th	7th	9th
Flavour score	8.64±0.07[a]	8.18±0.18[b]	7.89±0.89[b]	7.21±0.10[c]	6.50±0.15[d]
Body and Texture score	8.25±0.12[a]	7.86±0.14[b]	7.64±0.14[b]	7.18±0.09[c]	6.21±0.01[d]
Colour and Appearance score	8.21±0.10[a]	8.18±0.09[a]	8.03±0.03[a]	7.57±0.13[b]	7.36±0.13[b]
Overall acceptability score	8.39±0.12[a]	8.07±0.05[b]	7.93±0.05[b]	7.28±0.08[c]	6.61±0.09[d]

Values are the mean of three replicates with standard error.a, b, c, d…..different superscripts denotes significant ($p<0.05$) differences in sensorial quality of product throughout storage.

X) Change in moisture content (%) of steamed sweetened chhana during storage at 8±2°C

Moisture content of the products was reduced significantly ($p<0.05$) from 40.88% at 1st day of storage to 33.30% at 9th day of storage (Table 4). This phenomenon was might be due to the evaporation of moisture from product. Kumar[20] also observed reduction of moisture content in the chittaranjan (bhapasandesh) with progression of storage.

XI) Change in pH of steamed sweetened chhana during storage at 8±2°C

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pH of the product was reduced significantly ($p<0.05$) from 5.57 at 1 st day of storage to 4.16 at 9th day of storage (Table 4). The increase in lactic acid content and free fatty content during storage might be the reason of lowering pH in all samples.

XII) Change in tyrosine value (mg / 100 ml) of steamed sweetened chhana during storage at 8±2°C

Tyrosine value measures the extent of protein degradation. Tyrosine value of the product was also increased significantly ($p<0.05$) from 2.545 mg/100 ml at 1st day of storage to 6.55mg/100 ml at 9th day of storage (Table 4). The proteolysis occurs either due to protein oxidation or due to proteases enzymes present either in sample or produced by proteolytic bacteria. Dalsgaard et al. [21] observed light induced oxidation of protein in cheese. The lipid radicals, when interacted with protein resulted in higher level of dityrosine generation within the cheese (Dalsgaard et al.) [21].

Table 4. Chemical changes in steamed sweetened chhana during storage at 8±2°C

Parameters	Storage Day				
	st	rd		th	th
	1	3	5th	7	9
Moisture (%)	40.88 ± 2.42^{a}	38.72 ± 1.10^{ab}	35.89 ± 0.97^{bc}	33.61 ± 0.49^{c}	33.30 ± 0.43^{c}
Titratable acidity (% lactic acid)	0.563 ± 0.02^{d}	0.667 ± 0.07^{cd}	0.900 ± 0.10^{bc}	1.000 ± 0.10^{ab}	1.233 ± 0.07^{a}
pH	5.57 ± 0.03^{a}	5.50 ± 0.00^{a}	$5.19\pm.042^{b}$	5.21 ± 0.01^{b}	4.16 ± 0.08^{c}
Tyrosine (mg/100 ml)	2.545 ± 0.03^{d}	2.83 ± 0.08^{d}	3.24 ± 0.02^{c}	5.02 ± 0.09^{b}	6.55 ± 0.16^{a}
Thiobarbituric acid (TBA)(% malonaldehyde)	0.22 ± 0.00^{d}	0.27 ± 0.01^{cd}	0.53 ± 0.02^{c}	4.87 ± 0.19^{a}	4.39 ± 0.08^{b}
Free fatty acid (FFA) (mg/g)	0.006 ± 0.00^{c}	0.014 ± 0.00^{c}	0.012 ± 0.00^{c}	0.104 ± 0.00^{b}	0.209 ± 0.01^{a}

Values are the mean of three replicates with standard error.
a, b, c, d…..different superscripts denotes significant ($p<0.05$) differences in chemical quality of product throughout storage.

XIII) Change in free fatty acid content (FFA) (µg/g) of steamed sweetened chhana during storage at 8±2°C

The amount of FFA denotes the extent of fat lipolysis. FFA of the product was increased significantly ($p<0.05$) from 0.006mg/g at 1st day of storage to 0.209mg/g at 9th day of storage. The rate of lipid deterioration or lipolysis was low at earlier stage of storage. Park [22] reported

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that lipolysis of any dairy products are of three types- induced lipolysis, spontaneous lipolysis and microbial lipolysis. Psychotropic bacteria are the main source for lipase enzyme. Kumar et al. [18] also noticed an increase in free fatty acid level in chhana podo during storage.

CONCLUSION

The steamed sweetened chhana with desired quality was prepared by standardizing the level of sugars and processing parameter i.e. steaming time. Presence of sugar as well as steaming of the product enhance the palatability of chhana. The addition of sugar at the rate of 30% of the weight of chhana and steaming for 60 min was optimized for preparing steamed sweetened chhana. This sweet possesses enormous potentiality to be marketed by sweet manufacture. The shelf life of steamed sweetened chhana was estimated as nine day when product was packaged in three-ply laminated (PE/Al Foil/PE) pouch and stored at 8±2°C. There is a strong need for up-gradation of the technology standardized in the laboratory for the production of steamed sweetened chhana for commercial scale. Use of different active ingredients such as antimicrobial agents and nutraceutical along with chhana may help to enhance the shelf life and improve nutritional quality as well as nutraceutical value, respectively of steamed sweetened chhana. Studies on the effect of different packaging materials and packaging conditions like vacuum packaging, modified atmospheric packaging, active packaging may be a help for sweet manufacturers in enhancing shelf life.

FUTURE SCOPE OF THIS STUDY

There is a strong need for up-gradation of the technology standardized in the laboratory for the production of steamed sweetened chhana for commercial scale.

Exploring the feasibility of using other ingredients to enhance the palatability.
Use of different active ingredients along with chhana with an aim to enhance the shelf life, improve nutritional quality as well as provide beneficial health effect beyond nutrition.

Comparative studies of vacuum packaging, MAP and other active packaging to enhance the shelf life of steamed sweetened chaana.

Detailed investigation on the biochemical changes in the steamed sweetened chhana during storage. Investigation on the presence of pathogenic organisms and toxins produced by them the steamed sweetened chhana during storage is needed to be investigated.

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