RESEARCH ARTICLE

Manufacture of chhana podo by incorporation of passion fruit (*Passiflora edulis* Sims fo. *edulis*) pulp

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Abstract: A study on manufacture of chhana podo prepared by using cow milk by incorporation of passion fruit (*Passiflora edulis* Sims fo. *edulis*) pulp was carried out. The attempts have been made to study effect of different levels of passion fruit pulp, 0 (T1), 32% (T2), 34% (T3), 36% (T4) and 38% (T5) on sensory quality of chhana podo. Based on the sensory analysis, chhana podo prepared with 32 % passion fruit pulp (T2) was found superior over rest of the treatments. The chemical, microbial quality and color characteristics of both control and optimized treated sample were evaluated in the study. The latter was also estimated for total polyphenol content and was found to be 151.1 mg/100g.

Keywords: Chhana podo, Chemical quality, Passion fruit pulp, Polyphenol content

Introduction

Chhana podo is the only baked indigenous dairy product which is prepared from chhana (Kadam et al. 2017). According to the revised standards of FSSAI (2006), Chhana or Paneer means the

product obtained from any variant of milk, with or without added milk solids, by precipitation with permitted acidulants and heating. The process parameters for production of chhana from low fat cow milk were optimized by Jonkman & Das in 1993. In India, annual production of Chhana is about 1,00,000 tons (Chawla et al. 2009). Chhana podo, the sweet chhana based delicacy is a unique product of east India which is characterized by light brown color with sweet caramelized flavor and rich taste. It has moist crumb, moderately spongy cake-like texture and delicate body. Chhana podo has no proper size and shape and it is prepared as per desiredness. The size, shape and appearance of the product vary depending upon the manufacturers. Ghosh et al. (2002) conducted a market survey of chhana podo sold in Orissa with its characterization and utilization.

The traditional method of its production involves mixing of ingredients such as chhana, sugar, suji or maida at ambient temperature and prolonged baking in a microwave/ convection oven. Baking is the key step in the preparation of Chhana Podo. It is a complex process in which physical and biochemical changes occur simultaneously. Dash et al. (1999) reported a method for the preparation of Chhana Podo by mixing Chhana, sugar and refined wheat flour/semolina in the ratio of 20:5:1 (w/w) with small quantities of heated and clarified butter oil (ghee), and by baking at a temperature-time combination of 150°C for 90 min.

Kumar et al. (2002) reported on the optimization of ingredient and processing parameters during the manufacture of Chhana podo. Milk standardized to 4.5% fat and 8.5% SNF was heated to 85°C for 10 min. Citric acid solution was added for coagulation of milk. Coagulum was retained in whey for 15 min followed by dewatering using a specially designed centrifugal whey separation system. Then chhana was mixed with specified amount of 5% suji, 35% sugar and water in dough mixing system. The prepared Chhana podo premix was transferred to a rectangular aluminium pan previously lined with melted ghee. The covered pan was transferred to a hot air oven maintained at 200 ± 5°C, and was kept for 50 min.

Sensory and textural attributes showed many variations with regard to body and texture, color and appearance, flavor, sweetness and overall acceptability when observed in market

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sample of Chhana podo which was collected from reputed sweets shops of Bhubaneswar. It was observed that most preferred varieties having pleasant, and caramel flavor, fully developed coherent pores with moderate degree of softness, outer surface light brown and centre portion white, moist surface and optimum sweetness (Kumar, 2008).

Passion fruit is a popular name given to several species of the genus *Passiflora* that belongs to *Passifloraceae* family, which is distributed in regions of tropical and subtropical climate of the world. These fruits are important for their pulp, peel and possess high levels of bioactive compounds (Reis et al. 2018). Passion fruit appears to be a rich source of nutrients such as carbohydrates, vitamins, and minerals that are essential for life. The fruit contains large amount of nutraceutical, such as phenolic acids, in which anthocyanins and flavonoids are the majoritarian compounds. Espirito-Santo et al. (2013) studied the possibility of using passion fruit fiber as a neutral ingredient for the design of new high value-added yoghurt and also reported the rheology, spontaneous whey separation, microstructure and sensorial characteristics of probiotic yoghurts enriched with passion fruit fiber. Studies have been conducted in using passion fruit as a raw material for the development of juice beverage with rich flavor and pleasant taste (Zhu et al. 2017).

The antioxidant activity of passion fruit dietary fibre has been studied using ethanol solvent with ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid), DPPH (2,2-diphenyl-1-picrylhydrazyl) and FRAP (Ferric Reducing Antioxidant Power) assay and was determined to be 2.1 μ M TE (Trolox Equivalent) /g, 1.5 μ M TE/g and 4.6 μ M TE/g respectively (Martínez et al. (2012). It has been discovered that piceatannol (3,4,3',5'-tetrahydroxytrans-stilbene) is present in passion fruit seeds in large amounts and that this compound is the major component responsible for the passion fruit seed extract effects observed on melanogenesis and collagen synthesis (Matsui et al. 2010).

Kishore et al. (2011) evaluated the Total Soluble Solid content and titrable acidity in purple passion fruit pulp *Passiflora edulis* Sims which were found to be 15.30 and 3.80% respectively and total carotenoid content as determined by Pongener et al. (2013) was found to be 1467 μ g/100 ml. Chemical characterization of passion fruit *Passiflora edulis* f. *flavicarpa* seeds have been done by Silva et al. (2015) and found to have high nutritional value, proving to be a promising product, mainly because it contains significant amounts of proteinase. Mamede et al. (2017) studied the volatile composition of sweet passion fruit (*Passiflora alata* Curtis) and revealed the main classes as esters and terpenes. The aim of this study was to evaluate the chemical characteristics, color parameters and total polyphenol content of optimized treated sample (T2) of chhana podo. Excellent carotenoid profile and the presence of phenolic compounds such as carotenoids, flavonoids, anthocyanins and provitamin A content, of passion

fruit extract is expected to confer bioactive and therapeutic properties to the product.

Materials and Methods

Manufacture of chhana podo

For the preparation of chhana podo, cow milk was received from Dairy plant, College of Dairy Science and technology, Mannuthy, Thrissur, whereas passion fruit, baking powder, suji, and sugar were purchased from the local market. The chhana podo was prepared using milk of 3.5 fat and 8.7 SNF as per the procedure given below. Passion fruit pulp used for the preparation of treated samples possessed acidity of 2.765% citric acid. Some preliminary trials were conducted to determine appropriate level of addition of passion fruit pulp for incorporation in chhana podo. Four levels of addition of passion fruit pulp (32, 34, 36 and 38%) were selected on the basis of preliminary trials for further studies in six replications.

Sensory evaluation

In this study the organoleptic quality of control and treated samples of chhana podo was evaluated at by a panel of five semi trained judges on a 9-point hedonic scale where a score of 5 point represented 'dislike extremely' and score of 9 point represented 'like extremely' (Amerine et al. 1965). The samples for evaluation were marked suitably before serving the samples to the judges for sensory evaluation. The samples were evaluated in a sensory evaluation room with appropriate facilities.

Proximate analysis and total phenol content

The fat content of milk and chhana podo was determined by using standard Gerber method as per IS: 1224 (part-I), 1977. The acidity of milk and chhana podo was estimated according to IS: 1479, (part-I), 1960. The total solids and protein content of chhana podo were determined as per IS: 1479 (part-II), 1961. The ash content of chhana podo was determined as per the procedure quoted by AOAC (1975). The acidity of passion fruit pulp was determined as per the procedure given in AOAC (1975).

Total phenol content of the optimized treated sample was estimated as per the procedure mentioned by Swain and Hillis (1959). Data were statistically analyzed according to Snedecor and Cochran (1994) using randomized block design.

Microbial analysis

The microbiological analysis of the product was carried out as per the method described in IS: 1224 (part-I and part-II), 1981. Yeast & Mold Count was determined by plating 1:10 dilution of chhana podo suspension using Potato Dextrose Agar (Hi Media). The count was taken after 3- 5 days of incubation at 30-35°C. Coliform count was determined by plating 1:10 dilution of the

Fig.1a Optimized process of preparation of passion fruit pulp incorporated chhana podo

sample. Dilutions were plated using Violet Red Bile Agar (VRBA) media. These plates were incubated at 35°-37°C for 24-48 hours and there after counts were taken.

Evaluation of color characteristics

Color parameters of the samples of chhana podo were measured by MiniScan EZ spectrophotometer. Both control and optimized samples were tempered to room temperature and crushed using pestle and mortar. Crushed samples were filled in petriplates for taking the measurement. The color parameters such as 'L*', 'a*' and 'b*' values were noted; The color parameter 'L*' is a measure of lightness or luminance, which ranges from 0 to 100 [L* = 0 (black) and L* = 100 (white)] and 'a*' and 'b*' are the two chromatic components, which range from -120 to 120 [a* = -120

(green) and a* = 120 (red)] and [b* = -120 (blue) and b* = 120 (yellow)] respectively.

Statistical analysis

Data obtained from various experiments during optimization, was statistically analyzed by using statistical software SPSS 21.0. One way ANOVA for sensory evaluation of samples of chhana podo was done using Tukey test of SPSS.

Results and Discussion

Sensory evaluation

Table 1 disports the average scores obtained for control and treated samples for different sensory attributes. Higher score for flavor was secured by the control, T1 (7.82 ± 0.28) than other

Fig.1b Steps involved in the preparation of passion fruit pulp incorporated chhana podo

Table 1 Effect of incorporation of passion fruit pulp on the sensory attributes of chhanapodo

Attributes	Sensory Scores on 9 point hedonic scale				
	T1	T2	T3	T4	T5
Flavor	7.82 ± 0.28 ^c	7.55 ± 0.19 ^{bc}	6.83 ± 0.17 ^a	7.05 ± 0.42 ^{ab}	6.94 ± 0.25 ^a
Color & Appearance	8.00 ± 0.00 ^c	7.77 ± 0.09 ^{bc}	6.63 ± 0.12 ^a	6.83 ± 0.17 ^a	7.22 ± 0.25 ^b
Body & Texture	7.77 ± 0.50 ^b	7.66 ± 0.16 ^b	7.10 ± 0.17 ^{ab}	6.88 ± 0.09 ^a	7.27 ± 0.69 ^{ab}
Overall Acceptability	8.83 ± 0.86 ^c	7.66 ± 0.16 ^b	6.88 ± 0.34 ^{ab}	6.72 ± 0.25 ^a	7.10 ± 0.25 ^{ab}

Note: Figures are mean ± standard deviation of six replications. Values with different superscripts in a row are significantly different (p d" 0.01)

T1: Chhana podo without pulp; **T2:** Chhana podo with 32% pulp; **T3:** Chhana podo with 34% pulp; **T4:** Chhana podo with 36% pulp; **T5:** Chhana podo with 38% pulp

treatments & this may be probably due to the innate caramelized cooked and fresh flavor possessed by the product. Chhana podo incorporated with 32% fruit pulp was found to be superior in terms of acceptability and flavor. The scores obtained by sample T2 for color and appearance (7.77 ± 0.09) was not significantly (p d" 0.01) different from that of the control sample (T1) and this may be due to the reason that the amount of pulp added (32%) was not enough to make a noticeable change in the appearance of chhana podo. In the case of body and texture, control, T1 (7.77 ± 0.50) and chhana podo with 32% pulp, T2 (7.66 ± 0.16) samples scored the highest score compared to T3 and T4 samples. This can be accounted by the uniform baking and porosity possessed by the samples. The overall acceptability scores obtained by T1 (8.83 ± 0.86) and T2 (7.66 ± 0.16) samples was found to be higher than the other treatments. From the overall scores obtained for sensory attributes, it can be concluded that the chhana podo sample incorporated with 32% passion fruit pulp (T2) has exhibited better acceptability among other treatments and also showed higher scores resembling to that of control chhana podo (T1).

Proximate composition

The proximate analysis of control and optimized sample (T1) of chhana podo prepared by 0 and 32% levels of passion fruit pulp was carried out for moisture, fat, protein,

ash and titratable acidity. The results are showed in Table 2.

Fat content

The data from the study revealed that the variation in the fat content of chhana podo due to the incorporation of passion fruit pulp was found to be significant. The fat content decreased significantly with the addition of pulp. The average fat percentage of chhana podo at 0 and 32 % pulp addition were 14.73 and 13.17 percent respectively. The obvious reason is that due to the very low fat content of passion fruit pulp, there was reduction in the amount of fat in the product. Secondly, due to very low fat content of passion fruit pulp (Adeyeye and Aremu, 2017), its addition reduced the fat of the final product.

The main source of fat in chhana podo was mainly from chhana which contained on an average 23.17 per cent fat. The higher fat content was observed at T1 (0 per cent) i.e. podo without pulp. These results are quite comparable with the result reported by Kumar et al. (2002) who reported 15.50 per cent fat. Mane (2006) found the average per cent fat as 15.06 in chhana podo.

Moisture content

The moisture content of chhana podo showed significant increase in sample incorporated with 32% passion fruit pulp compared to that of control sample. This was obviously due to

Table 2 Chemical quality of control and optimized sample of passion fruit pulp incorporated chhana podo (%)

	Chemical composition		Significance
	T1	T2	
Fat	14.73 ± 0.195	13.17 ± 0.239	S*
Moisture	30.295 ± 0.522	34.495 ± 0.315	S*
Acidity	0.23 ± 0.007	0.64 ± 0.023	S*
Ash	1.65 ± 0.034	1.36 ± 0.02	S*
Protein	17.67 ± 0.091	18.85 ± 0.132	S*

Note: S*-Significant at 5% level of significance; NS*- Not significant at 5% level of significance

Table 3 Color parameters of control and optimized sample of passion fruit pulp incorporated chhana podo

Parameters	T1	T2	Significance
L*	58.33 ± 0.540	56.55 ± 0.306	S*
a*	10.67 ± 0.115	9.51 ± 0.146	S*
b*	28.24 ± 0.36	36.26 ± 0.54	S*

Note: S*- Significant at 5% level of significance; NS*- Not significant at 5% level of significance

very high moisture content of passion fruit pulp (seed and juice) (Adeyeye and Aremu, 2017). The chhana podo without passion fruit pulp contained 30.29 per cent moisture. The average values for moisture content in chhana podo were more or less similar to the figures reported by Kumar (2008) and Dash et al. (1999) as 65.57 to 73.29 per cent total solids. Mane (2006) observed an average of 74.81 per cent total solids in chhana podo.

Acidity

Addition of passion fruit pulp has resulted in significant increase in acidity of chhana podo. Acidity of control (T1) and optimized treated sample (T2) of chhana podo was found to be 0.23 and 0.64% lactic acid respectively. This increase in acidity was statistically significant ($p > 0.05$) which could be related to the increased acidity of passion fruit pulp 2.76% citric acid as compared to control chhana podo (0.23% lactic acid). Dash et al. (1999) reported that the titratable acidity of chhana podo samples laid in the range of 0.18 to 0.27 per cent and average value was found to be 0.20 ± 0.2 per cent. These variations in acidity were justified by the quality of raw milk and the amount and strength of coagulant used for chhana preparation.

Kumar et al. (2002) found 0.25 per cent acidity in chhana podo while optimizing the process for commercial production of chhana podo. The results of present study with respect to acidity were more or less in accordance with the findings reported by Dash et al. (1999) and Kumar et al. (2002). The results showed in Table 2 clearly reveal that the acidity of chhana podo increased significantly with the addition of passion fruit pulp.

Ash content

The average ash content of control and optimized treated sample of chhana podo was 1.65 and 1.36 per cent, respectively. The results for ash content depicted that addition of passion fruit

pulp resulted in decrease in the ash content of chhana podo. This may be probably due to very low ash content of passion fruit juice (0.34%) (Adeyeye and Aremu, 2017).

Ghosh et al. (1998) observed that the ash content of chhana podo samples lay in the range of 0.8-1.0 per cent. Dash et al. (1999) reported that the ash content of chhana podo samples were in the range of 0.93 to 1.52 per cent. The values obtained in the present study showed similar results. Dash et al. (1999) noted that the major source of ash in chhana podo was contributed by chhana and it changed with the initial quality of raw milk used for preparation.

Protein content

The protein content in the optimized treated sample of chhana podo (T2) was found to be significantly different from that of control sample (T1). An increase in protein content was noted in the treated sample due to the addition of pulp which contained protein as about 6.53g/100g of dry weight (Reis *et al.*, 2018). Control and treated samples of chhana podo contained 17.67 and 18.85 % protein content respectively.

Protein content in chhana podo was studied by Ghosh et al. (1998), Dash et al. (1999), Kumar et al. (2002), and Mane (2006), and was found to be 15 to 17, 16.3 to 21.08, 12 and 13.90 per cent respectively. These values are in agreement with the values obtained in the present study. Chhana was the major contributor of protein in chhana podo (Dash et al. 1999) and it was variable depending on the initial composition of milk used.

Total polyphenol content

Passion fruit is considered to have excellent functional properties due to the presence of its various nutritional components like phenolic constituents, anthocyanin, flavonoids, carotenoids and

other bioactive compounds. The amount of these nutritional elements was influenced by factors such as genotype, geographic effect, crop year, maturation and storage conditions (Souza et al. 2008; Cardenosa et al. 2016). Li et al. (2016) have summarized about antioxidant, anti-hypertension, anti-fungus, anti-diabetes, cardiovascular protection properties and anti-inflammation activities of passion fruit in their literature.

Total polyphenol content of the optimized treated sample was determined and was found to be 151.1 mg/100g. Amount of total carotenoids and phenolic compounds in passion fruit (*Passiflora edulis Sims fo. edulis*) pulp was reported to be 288.56 µg and 788.93 mg per 100 g dry weight respectively (Reis et al. 2018). They also found out the total flavonoid content in pulp to be 229.79 mg/100 g and about 12.35mg/100g dry weight kaempferol, the flavonoid constituent. These results revealed that passion fruit pulp have the potential to be used in different food formulations that would enhance its beneficial properties due to the presence of these nutritional components.

Microbiological quality

The coliform count in both control and optimized treated samples were nil whereas the yeast and mold count were found to be 30 and 50 cfu/g respectively being higher than that of reported by Kumar (2008) but within the limits of FSSAI microbiological standards, 2015. Higher yeast and mold count found in the treated samples may be due to the higher moisture content as a result of passion fruit pulp addition.

Color characteristics

The lightness value (L^*) of control (T1) and optimized sample (T2) was found to be 58.33 and 56.55 respectively and from this result, it can be inferred that the addition of pulp resulted in a decrease in lightness value of chhana podo. The values of chromatic components of control sample were found to be 10.67 and 28.24 respectively while those of optimized sample were 9.51 and 36.26. The values of L^* and a^* of T1 and T2 samples were significantly different. Kumari (2013) evaluated the lightness value of the upper crust of chhana podo and the value was found to be decreasing with increasing temperature and time during baking.

Conclusions

From the present study, it can be concluded that the addition of passion fruit pulp has increased the functionality of chhana podo and this product had the potential to gain flavour among consumers due to its therapeutic and nutritive advantages. From the sensory analysis of the treatment samples, higher acceptability was realized for T2 sample of chhana podo (with 32% passion fruit pulp added) than remaining treatments. The chemical composition of the control and optimized sample was studied and total polyphenol content of the latter has also been

estimated which evidenced its significant beneficial effects on health.

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