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ORIGINAL ARTICLE

Influence of stabilizers on quality of sandesh from buffalo milk

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Abstract Buffalo milk standardized to solids-not-fat (SNF) to fat ratio of 1.4 was added separately with 0.1% (w/w) each of carrageenan, sodium alginate and carboxymethyl cellulose and then heated, cooled and coagulated to obtain chhana which was converted into sandesh by adding 1.5% (w/w) wheat flour and 25% (w/w) cane sugar followed by heating (40 min/kg chhana). The treated samples of sandesh were compared with control prepared similarly manner but without stabilizer. Addition of stabilizer decreased hardness, fracturability, adhesiveness, cohesiveness, gumminess and chewiness of sandesh and improved sensory body and texture, colour and appearance as well as overall acceptability of the product when compared with control. Textural and sensory properties of different samples of sandesh indicated that the product made by adding carrageenan proved best. Carrageenan at 0.1% produced better results in terms of textural and sensory profile of sandesh as compared to 0, 0.075 and 0.125% (w/w) of carrageenan.

Keywords Sandesh · Buffalo milk · Carrageenan · Sodium alginate · Carboxymethyl cellulose · Quality

Sandesh is a sweet product mostly produced in unorganized small-scale sectors wherein variations in quality between batches, days of production and shops are noticed (Yadav et al. 1989, Patil 2005). PFA (1995) also does not specify any standard for sandesh. The cost of raw materials for sandesh preparation is about 40% of sale price, which makes it a profitable product (Parekh 1994).

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Cow milk is preferred to buffalo milk for the production of sandesh due to the unique chemical composition of the former. Buffalo milk on the other hand tends to produce a hard body and coarse texture in sandesh due to its higher concentrations of proteins and minerals. Since buffaloes contribute to more than 50% of country's total milk production, it is necessary to develop a standardized procedure for the production of sandesh from buffalo milk. Suitable modifications in the manufacturing procedure and use of additives might help to improve the quality of sandesh from buffalo milk through regulation of proportions and state of the major constituents in the product namely water, protein and fat. Carrageenan, sodium alginate and carboxymethyl cellulose (CMC) are normally used as thickeners and emulsifiers in many dairy products and other processed foods to improve water binding and fat retention capacity (Wallingford and Labuza 1983). An attempt was, therefore, made to develop a standardized procedure for the manufacture of sandesh from buffalo milk to provide avenues for utilization of buffalo milk in the production of sandesh and other chhana-based sweetmeats, maintain uniformity in product quality, pave the way for mechanization of manufacturing process and help in the formulation of legal standards for sandesh. In the present study, effects of addition of different stabilizers and determination of optimum level of addition of most suitable stabilizer to buffalo milk, on the quality of sandesh have been reported.

Materials and methods

Buffalo milk procured from the local market was standardized to solids-not-fat (SNF) to Fat ratio of 1.4, heated to 90°C and added separately with carrageenan,

sodium alginate and carboxymethyl cellulose (CMC), each at 0.1% level (by weight of milk), mixed thoroughly followed by boiling of milk-stabilizer mixture and cooling to 70°C followed by coagulation with hot (70°C) 1% citric acid solution. After coagulation, whey was removed through filtration using a fine muslin cloth and the chhana obtained was passed through a grinder to obtain a smooth body in chhana. Wheat flour at the rate of 1.5% (by weight of chhana) was added to the chhana and the mixture kneaded manually for about 5 min to get a smooth paste followed by slow heating of the mixture on a hot pan to make sandesh. Ground cane sugar at 25% level (by weight of chhana and wheat flour mixture) was slowly added to the content during cooking and the content was cooked for 40 min (for 1 kg chhana) to get sandesh. The product was spread uniformly on a stainless steel tray presmeared with vegetable oil, allowed to cool to room temperature (30±2°C), cut into desirable size (3 cm×2.5 cm×1.5 cm, approx.) and analysed for various quality parameters.

In the second experiment, the method as detailed above was repeated except only carrageenan was added to milk separately at 0, 0.075, 0.100 and 0.125% (w/w) levels without using sodium alginate and CMC.

Contents of moisture, fat, ash and free fatty acids (% oleic acid) as well as titratable acidity (% lactic acid) in the sandesh samples were estimated following the methods as described in ISI (1981). Samples were also analysed for protein contents by micro-Kjeldahl method (AOAC 1995) while the total carbohydrate contents in sandesh were calculated by difference.

A Texture Analyser (Model: TAHDi, Stable Micro System, UK) fitted with a 250 kg load cell was used for two bites linear compression of sandesh. A cross head pre-test speed of 2 mm/s, test speed of 5 mm/s, post-test speed of 5 mm/s and interval of 5 s between two successive bites were employed for 50% compression of samples. A cylindrical probe of 75 mm diameter was used for textural study. The texture analyser having separate software (Texture Expert) for its operation was run under Windows environment to get the Texture Profile Analysis (TPA) data from the measurements. The hardness, fracturability and adhesiveness were directly calculated from Force—Time curve while other parameters were obtained directly from the Microprocessor.

Products were evaluated for sensory flavour, body and texture, colour and appearance as well as overall acceptability by a semi-trained panel of judges consisting of 7 members using a 9-point Hedonic scale. The judges comprised of teachers of the Faculty of Dairy Technology of the University who received prior training on various desirable properties and defects in sandesh. The scores in the Hedonic scale were: 9—liked extremely, 8—liked very much, 7—liked moderately, 6—liked slightly, 5—neither liked nor disliked, 4—disliked slightly, 3—disliked moderately, 2—disliked very much, and 1—disliked extremely. Three trials were conducted for each experiment. Data were statistically analyzed using statistical software package (Snedecor and Cochran 1994).

Results and discussion

Yield of sandesh varied from 15.5 to 16.2% (Table 1). Highest yield was obtained in the sample made by using carrageenan. Moisture content was highest in carrageenan followed by sodium alginate, CMC and control. Contents of protein and total carbohydrates were lowest in carrageenan samples. Highest fat content in control and lowest in sodium alginate samples were noticed. Titratable acidity (TA) followed a pattern of control—carrageenan—sodium alginate—CMC samples in increasing order. Higher moisture content in carrageenan samples might have caused a decrease in the contents of most of the milk constituents in the sample. Nonsignificant differences in protein and total carbohydrates among all samples were noticed. Control differed ($p<0.05$) in moisture content from those of sodium alginate and carrageenan, fat from that of sodium alginate, FFA from sodium alginate and TA from those of sodium alginate and CMC samples. An increase of 3% in the yield of chhana due to addition of 0.8% CMC to buffalo milk was reported by Sen and Rajorhia (1999).

Addition of stabilizer, in general, decreased hardness, fracturability, adhesiveness, cohesiveness, gumminess and chewiness in the samples (Table 1). Lowest hardness, fracturability, cohesiveness, gumminess and chewiness were carrageenan samples. Control samples differed ($p<0.05$) in hardness with sodium alginate and carrageenan, fracturability and gumminess with sodium alginate, carrageenan and CMC, adhesiveness with sodium alginate and CMC, springiness and cohesiveness with sodium alginate and carrageenan and chewiness with carrageenan samples. CMC was not effective in enhancing the rheological properties of buffalo milk sandesh as it indicated nonsignificant differences with control in hardness, springiness, cohesiveness and chewiness. Hardness which is defined as the force needed to compress a food item between the molars in the mouth, is an important rheological parameter in sandesh. Buffalo milk produces a harder product compared to cow milk due to presence of high contents of divalent cations such as Ca^{++} and Mg^{++} and a lower amount of monovalent cations and anions like Na^{+}, K^{+} and Cl^{-} than cow milk (Sindhu and Singhal 1988, Sindhu 1995). Addtion of sodium alginate at 0.2% level to buffalo milk during the manufacture of shrikhand was considered as unsuitable by Desai et al. (1987) as the chakka obtained

Table 1 Effect of addition of different stabilizers to (0.1%) buffalo milk on quality of sandesh

	Control	Sodium alginate	Carrageenan	Carboxymethyl cellulose	CD value
Chemical (n=3)					
Yield,%	15.5±0.36^{a}	16.0±0.28^{ab}	16.2 ±0.21^{b}	15.7±0.31^{ab}	2.03
Moisture,%	27.0±0.41^{a}	28.4±0.38^{bc}	29.0 ±0.34^{b}	27.9±0.37^{ac}	2.60
Fat,%	21.9±0.26^{a}	20.1±0.29^{b}	21.7±0.36^{a}	21.4±0.24^{a}	2.03
Protein,%	12.4±0.21^{a}	12.0±0.22^{a}	11.9±0.25^{a}	12.2±0.21^{a}	1.54
Total carbohydrates,%	37.1±0.29^{a}	36.8±0.34^{a}	36.8±0.27^{a}	36.9±0.32^{a}	2.14
Ash,%	1.6±0.03^{a}	1.6±0.04^{ab}	1.6±0.02^{b}	1.6±0.04^{ab}	0.24
Free fatty acids,% oleic acid	1.7±0.04^{a}	1.5±0.04^{bc}	1.6±0.02^{ac}	1.6±0.03^{ac}	0.22
Titratable acidity,% lactic acid	0.61±0.02^{a}	0.70±0.03^{b}	0.66±0.02^{ab}	0.79±0.05^{c}	0.22
Rheological (n=3)					
Hardness, g	3492.7±91.86^{a}	3017.9±152.50^{bc}	2801.9±119.90^{b}	3276.5±144.12^{ac}	894.87
Fracturability, g	44.9 ±1.33^{a}	37.2±1.25^{b}	29.8±2.50^{c}	40.7±1.77^{b}	12.36
Adhesiveness, gs	17.2 ±1.47^{a}	8.0±1.24^{b}	13.5±1.84^{ac}	10.2±2.01^{bc}	11.57
Springiness, mm	00.157±0.005^{a}	0.170±0.007^{b}	0.184±0.004^{c}	0.162±0.005^{ab}	0.037
Cohesiveness	00.188±0.006^{a}	0.153±0.006^{b}	0.136±0.007^{c}	0.175±0.005^{a}	0.042
Gumminess, g	497.3±8.76^{a}	454.7±12.74^{b}	419.1±11.63^{c}	471.8±13.14^{c}	81.07
Chewiness, g mm	92.6±6.85^{a}	79.7±4.16^{ab}	74.9±5.75^{b}	86.5±5.72^{ab}	39.53
Sensory (n=7 panelists)					
Flavour	7.3±0.26^{a}	7.0±0.17^{b}	7.1±0.25^{b}	6.7±0.29^{c}	3.26
Body and texture	7.0±0.40^{a}	8.0±0.19^{b}	8.2±0.24^{c}	7.2±0.21^{d}	3.58
Colour	7.7±0.34^{a}	8.3±0.28^{b}	8.5±0.23^{c}	7.8±0.26^{a}	3.74
Overall acceptability	6.8±0.27a	7.5±0.35b	7.7±0.23b	7.0±0.39a	4.20

n=3, Mean±SE with different superscripts in a row differ significantly (p<0.05)

after removal of a considerable quantity of moisture from dahi had grainy texture compared to control although such addition gave higher yield than control. Sachdeva and Singh (1988) noticed that addition of 0.1 and 0.2% CMC increased moisture retention in buffalo milk paneer but produced a product with poor body and texture.

Flavour and body and texture of control differed (p< 0.05) with those of treated samples (Table 1). Colour and appearance and overall acceptability of control samples showed significant (p<0.05) differences with those of sodium alginate and carrageenan samples only. Flavour score of control was highest but scores for other attributes were lowest in control. Overall acceptability of carrageenan was highest followed by sodium alginate, CMC and control in decreasing order of preference.

Results indicated that addition of stabilizers like sodium alginate, carrageenan and CMC separately to buffalo milk at 0.1% level improved the quality of sandesh; carrageenan however proved most effective in enhancing the quality of the product.

Yield of the carrageenan products varied from 15.6 to 16.9% (Table 2). Yield, moisture and titratable acidity indicated a direct relationship while fat, protein, carbohydrates and free fatty acids had an inverse relationship with the levels of stabilizer added. No clear cut relationship between ash content and the level of carrageenan was discernible. Addition of stabilizer might have increased the yield of the product through retention of higher moisture content which in turn reduced the concentration of fat, protein, carbohydrate and free fatty acids per unit mass in the products. Carbohydrate and titratable acidity did not differ significantly while significant (p<0.05) differences in yield, moisture, fat, ash and FFA of control with those of 0.100 and 0.125% carrageenan samples were noticed. Protein content of control differed (p<0.05) with that of 0.125% carrageenan samples only. Samples of 0.100 and 0.125% carrageenan did not differ significantly in any of the chemical parameters studied. But 0.075% carrageenan samples differed (p<0.05) in yield, moisture, fat and FFA with 0.125% and, in moisture and fat with those of 0.100% carrageenan samples. Guiseley et al. (1980) observed that k-carrageenan exerts a stabilizing effect on milk k-casein due to charge interaction, gets incorporated into the network and prevents whey separation. According to the authors, gelation of k-carrageenan occurs in presence of cations such as K^{+} and Ca^{++} and the strength of carrageenan gels depends on carrageenan concentration as well as type and concentration of monovalent cations.

Rheological properties of sandesh (Table 2) indicated an inverse relationship of level of carrageenan with hardness,

Table 2 Effect of addition of carrageenan at different levels to buffalo milk on quality of sandesh

Parameter	Level of carrageenan (%)				CD Value
	0	0.075%	0.100%	0.125%	
Physico-chemical (n=3)					
Yield,%	15.6±0.30^{a}	16.1±0.23^{ab}	16.4±0.24^{bc}	16.9±0.28^{c}	1.83
Moisture,%	27.1±.40^{a}	27.9±0.38^{a}	29.0±0.33^{b}	29.6±0.37^{b}	2.58
Fat,%	21.7±0.27^{a}	21.5±0.26^{a}	20.8±0.29^{b}	20.6±0.31^{b}	1.95
Protein,%	12.9±.28^{a}	12.6±0.23^{ab}	12.4±0.27^{ab}	12.1±0.24^{b}	1.71
Total carbohydrate,%	36.6±.38^{a}	36.4±0.31^{a}	36.2±0.25^{a}	36.1±0.21^{a}	2.05
Ash,%	1.7±0.03^{a}	1.6±0.02^{ab}	1.6±0.03^{b}	1.6±0.04^{bc}	0.21
Free fatty acids,% oleic acid	1.8±0.05^{a}	1.7±0.03^{ab}	1.7±0.03^{bc}	1.6±0.05^{c}	0.29
Titratable acidity,% lactic acid	0.58±0.02^{a}	0.61±0.04^{a}	0.62±0.03^{a}	0.65±0.04^{a}	0.23
Rheological (n=3)					
Hardness, g	3408.7±203.09^{a}	3071.4±136.19^{ab}	2796.5±100.85^{bc}	2603.3±147.13^{c}	1048.74
Fracturability, g	46.2±3.09^{a}	36.4±2.27^{b}	33.1±2.15^{b}	31.3±2.45^{b}	17.44
Adhesiveness, gs	17.9±1.45^{a}	14.4±2.43^{bc}	11.0±1.39^{ab}	9.6±1.12^{c}	11.59
Springiness, mm	0.152±0.003^{a}	0.167±0.004^{b}	0.176±0.004^{b}	0.190±0.006^{c}	0.03
Cohesiveness	0.184±0.006^{a}	0.166±0.005b	0.141±0.006^{c}	0.127±0.005^{d}	0.04
Gumminess, g	491.4±16.91^{a}	463.2±28.50^{ab}	432.9±23.51^{b}	445.6±22.74^{ab}	161.34
Chewiness, g mm	90.8±4.08^{a}	85.3±6.28^{ab}	76.9±6.16^{bc}	68.8±4.99^{c}	37.79
Sensory (n=7 panelists)					
Flavour	7.4±0.27^{a}	7.2±0.22^{ab}	7.1±0.29^{b}	6.9±0.37^{c}	3.88
Body and texture	6.9±0.35^{a}	7.6±0.36^{b}	8.1±0.39^{c}	7.8±0.28^{b}	4.58
Colour and appearance	7.6±0.34^{a}	8.1±0.28^{b}	8.5±0.18^{c}	8.3±0.22^{b}	3.48
Overall acceptability	7.0±0.26^{a}	7.3±0.23^{b}	7.6±0.33^{c}	7.4±0.27^{b}	3.63

Mean±SE with different superscripts in a row differ significantly (p<0.05), n=3

fracturability, adhesiveness, cohesiveness, gumminess and chewiness, and a direct relationship with springiness. Control samples differed (p<0.05) in hardness and chewiness with those of 0.100 and 0.125%, in fracturability, springiness and cohesiveness with those of 0.075, 0.100 and 0.125%, in adhesiveness with 0.075 and 0.125% and in gumminess with 0.100% carrageenan samples only. Hardness, adhesiveness, springiness and cohesiveness of 0.100 and 0.125% carrageenan showed differences (p<0.05) between themselves while 0.075% had significant (p< 0.05) differences in hardness, springiness, cohesiveness and chewiness with 0.125% carrageenan samples. Higher retention of moisture due to addition of stabilizer might be responsible for the decrease in hardness in the products. Use of carrageenan decreased penetration value, extruder friction and wheying off in low fat spread, extent of which increased with increase in level of carrageenan and was accompanied by a significant increase in scores for body and texture as well as flavour in shrikhand (Prajapati et al. 1990). The authors also reported an improvement in spreadability and flavour of low fat spread showing less wheying off when a combination of carrageenan (0.1%) and glycerol monostearate (0.3%) were used.

Sensory profile of sandesh samples (Table 2) revealed that flavour scores of sandesh had an indirect relationship with level of carrageenan. But the scores obtained by the samples for body and texture, colour and appearance as well as overall acceptability did not show any clear cut relationship with carrageenan level. Control samples differed (p<0.05) in flavour with 0.100 and 0.125% carrageenan, and in body and texture, colour and appearance as well as overall acceptability with all the treated samples. Samples with 0.100 and 0.125% carrageenan differed (p< 0.05) between themselves in all the sensory attributes. Prajapati et al. (1990) reported an improvement in flavour of low fat spread when a combination of carrageenan (0.1%) and glycerol monostearate (0.3%) were used. In the present study also, an improvement in the sensory quality of sandesh could be noticed due to the incorporation of carrageenan into buffalo milk prior to manufacture.

Conclusion

Quality of sandesh from buffalo milk could be improved through incorporation of stabilizers such as sodium alginate,

carrageenan or CMC into milk prior to manufacture. Among stabilizers, carrageenan proved to be most suitable. A level of 0.1% carrageenan produced better results in textural and sensory properties of buffalo milk sandesh compared to control and the levels of 0.075 and 0.125% of carrageenan.

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