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Development of spiced and smoked sausage from buffalo skim milk

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Abstract
Sausages are immensely popular food products which are basically emulsified and formed products, typically made from ground meat (generally beef or pork), and optionally added with spices, herbs, salt and may or may not be smoked. Development of a sausage like product from milk would, therefore, provide a scope for product diversification and also help to bring about expansion of market potential for dairy products. The present research work was, therefore, conducted to develop a sausage like emulsified and formed product from buffalo skimmed milk chhana added with spices and salt, and finally smoked in a chamber. Spices used to develop desirable sensorial characteristics in buffalo skimmed milk sausage included coriander, cumin seeds, red chili, black pepper, clove, turmeric, cinnamon. This may utilize the surplus milk solids available in the country to prepare a protein-rich meat sausage analogue.
In an effective manner which is likely to cater to the need of fat-conscious consumers. The level of ingredients and processing parameters such as level of milk fat in the skimmed milk, level of spice mix and salt and smoking time for making buffalo skimmed milk sausage were optimized on the basis of sensory evaluation of the product. Buffalo milk containing 0.5% fat,spice mix and salt at the rate of 1.25 and 1%, respectively of the weight of chhana and smoking of the mixture of chhana, spice mix and salt for 15 min in a hot smoke chamber were selected for the development of spiced and smoked skimmed buffalo milk sausage with desirable sensorial attributes.

Keywords: Sausage, Spice mix, skim milk, Chhana, smoking, sensory quality

Introduction
Milk quality deteriorates rapidly at high ambient temperatureand this has prompted mankind to find out suitable methods for preserving milk solids. About 50%of the total milk produced in India is used for making traditional Indian dairy products, among which production of chhana is an easier, cheaper and convenient method of preserving milk solids. Chhana is a heat and acid coagulated unripened variety of soft cheese and is used in the preparation of a variety of it sweetmeats. It has an acidic flavour and slightly sweetish tasteand contains almost all the milk constituents in concentrated form. Cow milk is suitable for making chhana. But buffalo milk produces an undesirably hard and coarse chhana, not suitable for sweetmeat purposes. The superior quality of chhana from cow milk is due to its unique physico-chemical composition compared to buffalo milk. Normally 5 – 6% fat in milk is required to make chhana which conforms to the Food Safety and Standards Regulations (FSSR, 2017) [5]. As per the FSSR (2017) [5], 'Chhana or paneer means the product obtained from cow or buffalo or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 60% moisture and the milk fat content shall not be less than 50% of the dry matter. Milk solids may also be used in preparation of this product'.However, with the existing technologies, it is difficult to get more than 60 percent moisture in chhana without compromising its quality. Milk fat is a costly commodity in India and as such presence of high fat content in chhana not only increases its cost but also raises apprehensions about its possible adverse effects on health as epidemiological studies reveal a positive correlation between the dietary intake of saturated fats (dairy and meat products) and mortality from coronary heart diseases (Wen and Gershaff, 1973) [10]. More and more people are avoiding intake of high fat dairy products now-a-days. This is evident in the consumer market as demand for low-fat dairy products increased virtually in every major dairy product category world over (Anon., 1990) [2].
There are over 200 varieties of sausages sold in the United States alone, out of which frankfurters are the most popular ones. Sausages are prepared within a casing. Natural casings are made from cleaned animal intestines of different sizes for different sausages. But they are expensive and non uniform. Artificial casings made up of regenerated collagen, cellulose materials or plastic films are more commonly used now-a-days as the casings hold the ground meat together and prevent excessive moisture and fat losses during cooking and smoking operations (Andres *et al.*, 2007).

In the 18th century, drying included use of smoke to hasten the process of sausage making, but it imparted some important flavor changes in the product. Smoked versions of brinjal, fish, chicken, mutton, pork etc. are quite popular throughout the country. The composition of smoke is very complex; more than 400 volatile substances have been identified in wood smoke. The chemical composition depends on the temperature of the smoke generation, the kind of wood used, the method used for developing the smoke, the water content in the wood and addition of air and water. Smoking not only enhances flavor but also contributes towards enhancement of keeping quality due to presence of chemical compounds some of which may have carcinogenic effects if ingested in large doses. Smoke compounds include nitrogen oxide, aromatic polycyclic hydrocarbons, phenolic compounds, furans, carbonyl compounds, aliphatic carboxylic acids, tar compounds etc. Some of these compounds are not very reactive and have a high boiling point like polycyclic aromatic hydrocarbons and phenolic compounds. Many of the volatile and more reactive compounds will very seldom be found in the food. Smoking decreases water activity of the product and affects hardness and stability of protein matrix due to moisture reduction (Andres *et al.*, 2007). Products are smoked either by direct exposure to smoke within the same chamber or by the smoke produced in a different chamber and then conducted to the product through pipe. Though smoking has been widely used in other type of animal foods, its use in dairy products is not common except in some kinds of cheeses like Bandel cheese. Since most of the whole milk or skim milk products are sweet in taste, smoking may not go along with them. But paneer is mostly used for making culinary dishes which offers a good scope to make an attempt for preparing a smoked product out of it. Since smoke is likely to mask the sweetish and fatty flavor in paneer, skim milk could be used in the preparation of a smoked buffalo skim milk sausage. Development of low-fat smoked sausage type dairy product from buffalo skim milk can provide adequate nutrition in a cost effective manner, gainfully utilize surplus skim milk available in the country, cater to the need of fat-conscious and variety loving consumers, introduce smoking as a tool to develop a variety of dairy products to meet the requirements of product diversification and expansion of market potential for dairy products. The present study was, therefore, undertaken to optimize the level of ingredients as well as process parameters for production of smoked sausage from buffalo skim milk.

Materials and Methods

Raw materials

Fresh buffalo milk was collected from the Students' Dairy Plant in the Faculty of Dairy Technology of the West Bengal University of Animal and Fishery Sciences located at Mohanpur, Nadia, West Bengal. Buffalo milk was separated in the laboratory using a centrifugal cream separator to get skim milk which was standardized to 0.5% fat and 9% SNF. Common salt (brand: Tata salt, Tata chemicals Ltd., Mumbai)and spices like coriander, cumin, red chili, black pepper, clove, turmeric, cinnamon and aniseed were procured from the local market at mohanpur, Nadia, West Bengal. Saw dust was obtained from a carpentry shop located in the market at Bara Jaguli in the district of Nadia, West Bengal, dried under sun before using the same to produce smoke for experimental use. Artificial synthetic casings made up of cellulose acetate were procured from the Haringhata meat processing plant, Mohanpur, Nadia, West Bengal.

Preparation of buffalo milk sausage

Buffalo milk was standardized to different fat levels such as 0.5, 2.0 and 3.5%, and separately heated to 90°C without holding, cooled to 70°C, coagulated with citric acid solution (strength 1%), coagulum was held undisturbed for 10 min, filtered through a fine muslin cloth to separate whey and collect the resultant chhana in the cloth. The chhana so prepared was added separately with 1.00, 1.25 and1.50% of spice mix and also added separately with 1.0% and 1.5% of common salt and thoroughly mixed followed by smoking in the smoking chamber separately for 15, 30 and 45min and stuffing in artificial casings toprepare milk sausage.

Sensory evaluation

The samples of sausages were subjected to sensory evaluation by a panel of five judges based on 9-point hedonic scale to select the fat level in initial buffalo milk for the preparation of buffalo milk sausage and then in further experiments amount of spice mix, duration of smoking (hot smoke) and level of common salt in the final formulation was optimized.

Chemical analysis of the product

The procedure as described in ICAR Bulletin No. 70 (1951) [6] for chhana was followed for sampling. About 20gm of the product was taken, finely ground and kept in screw capped plastic sample bottles at refrigeration temperature (7±1°C) till analysis was completed. The moisture content was determined by the gravimetric method as described in BIS (1961) [7]. The total fat content in sample was determined by Rose Gottlieb method as per SP: 18 Part XI- 1981 [8]. Protein content in the samples was estimated by Micro Kjeldahl method as described in AOAC (1980) [3]. The ash content in the sample was determined by method described in IS: SP: 18 (part XI, 1981) [8].

Statistical analysis

The data obtained were subjected to statistical analysis (Snedecor and Cochorn, 1989) [9]. Data were subjected to analysis of variance and means were compared by critical difference.

Result and Discussion

The mean values for various sensory attributes of smoked sausage made from buffalo skim milk standardized separately at 0.5 (i), 2.0 (ii) and 3.5% (iii) fat are presented in Table 1 and their ANOVA in table 2. ANOVA indicated that level of fat in buffalo milk significantly ($p<0.05$) affected flavour and highly significantly ($p<0.01$) influenced body and texture (BT) as well as overall acceptability (OA) of the smoked sausage samples. The scores for colour and appearance (CA) of the smoked sausage samples from buffalo milk ranged from 7.05 – 7.67, while those for flavour and BT varied from 7.10–7.65 and 6.60–7.72, respectively. CA score of the milk sausage, however, was not significantly ($p>0.0.5$) influenced by the level of fat in milk. OA scores of the samples ranged from 7.05–7.85. All the samples of smoked buffalo milk sausage (SBMS) were acceptable to the judges. It was noticed that BT scores of the samples were directly related to the fat level. SBMS made from milk containing 3.5% fat scored highest for all the sensory attributes as well as OA, while that from 2.0% fat milk scored higher than 0.5% fat milk for BT only. For all other sensory attributes SBMS, 0.5% fat buffalo milk obtained higher scores than 2% fat buffalo milk. Results indicated that an acceptable quality SBMS could be prepared from buffalo milk standardized separately to 0.5, 2.0

and 3.5% fat. However, SBMS made from 3.5% fat buffalo milk was judged as best. Since one of the objectives of the present
investigation was to recommend avenues for utilization of skim milk and also in view of the acceptable quality of SBMS prepared from 0.5% fat buffalo milk, a fat level of 0.5% in buffalo milk was recommended for production of sausage in subsequent experiments.

Table 3 and 4 represent the average values for different physico-chemical properties of buffalo skim milk sausage smoked separately for 0 (control), 15 (i), 30 (ii) and 45min (iii) and the analysis of variance (ANOVA) showing the effect of smoking time on physicochemical parameters of smoked buffalo skim milk sausage (SBSMS), respectively. ANOVA revealed that smoking duration significantly (p<0.05) influenced the content of fat but highly significantly (p<0.01) affected the yield, contents of moisture, protein and ash as well as titratable acidity (TA) of the product. Yield of SBSMS ranged from 10.39% for sample (iii) to 11.96% for control while contents of moisture varied from 54.76% in sample (iii) to 60.62% in control. The average values for fat, protein and ash in the samples ranged from 3.21 to 3.49%, 31.61 to 34.12% and 2.77 to 3.09%, respectively. TA of SBSMS samples varied from 0.21% lactic acid in sample (iii) to 0.23% lactic acid in control. Yield and moisture content of the product decreased with increase in smoking duration, while contents of fat, protein and ash indicated a reverse trend and decreased with advancement in smoking period. Decrease in moisture content in the samples might have caused an increase in the concentrations of other constituents like fat, proteins, ash etc. per unit mass in the product. Titratable acidity of the sample also showed a decreasing trend with increase in smoking time. It is clear from the Table 3 that smoking time was directly related to the contents of fat, protein and ash as well as TA and inversely related to yield and moisture content of the product.

Table 5 and 6 represent the average scores for various sensory attributes of buffalo skim milk sausage smoked separately for0 (control), 15 (i), 30 (ii) and 45min (iii) and the analysis of variance (ANOVA) showing the effect of smoking time on the sensory attributes of smoked buffalo skim milk sausage (SBSMS) respectively. According to the ANOVA, smoking time highly significantly (p<0.01) influenced colour and appearance (CA), flavour, body and texture (BT) as well as overall acceptability (OA) score of the product. The average scores for CA, flavour, BT and OA of SBSMS ranged from 5.85–7.60, 6.05–7.80, 5.70–7.85 and 5.70–7.90, respectively. Highest score for CA, flavour, BT and OA was obtained by the sample (i). Control samples scored higher than sample (ii) and (iii) but lower than sample (i) for all the sensory attributes. Out of all the samples of SBSMS, those prepared by smoking the skim milk sausage for 45min scored less than 6 for all the sensory attributes except flavor (6.05) and as such were not considered as acceptable to the judges. Smoking of SBSMS for 15 min might have improved CA, flavour, BT when compared with control, but higher duration smoking had adverse effect on the sensory properties of the product. Smoking induced a desirable and characteristic aroma in the product which might be responsible for better flavour in sample (i). The lower scores for BT of (ii) and (iii) as compared to control could be due to the drying effect of smoking operations on the samples (Andres *et al.*, 2007). OA of sample (i) was highest followed by control, sample (ii) and (iii) in decreasing order. All the samples except (iii) were however acceptable to the judges. From the results of experiment, it was concluded that smoking time was directly related to the contents of fat, protein and ash as well as TA and inversely related to yield and moisture content of the SBSMS mainly due to the drying effect of smoking operation. Smoking of buffalo skim milk sausage for 15 min produced better results in terms of the sensory parameters of SBSMS as compared to control and also those smoked for 30 and 45 min. It is, therefore, recommended that for preparing a good quality SBSMS, the product should be smoked for 15 min for acceptable physico-chemical properties and improved sensory quality.

Table 7 and 8 represent the average scores for different sensory attributes of SBSMS made by separately mixing spice mix at1.00 (i), 1.25 (ii), 1.50% (iii) to skim milk chhana which were smoked for 15 min and their ANOVA, respectively. ANOVA revealed that level of spice mix highly significantly (p<0.01) influenced colour and appearance (CA), flavour, body and texture (BT) as well as overall acceptability (OA) score of the product. The scores for CA, flavour, BT and OA for sample (i), (ii) and (iii) ranged from 5.85 to 7.40, 6.05 to 7.60, 5.70 to 7.30 and 5.70 to 7.60, respectively. Among the samples highest scores for flavour, BT and OA were obtained by sample (ii), where as sample (i) scored highest for only CA. As per the scores of sensory evaluation, sample (iii) was not acceptable to the judges as it scored less than six for all the attributes except flavor for which it obtained a score of 6.05.Thecompositionof spice mix is expected to influence the sensory characteristics of SBSMS as most of the spice mix ingredients possess characteristic flavor. Based on results, it appears that a level of 1.25% of spice mix was optimum for producing a good quality SBSMS as compared to the spice mix level of 1.00 and 1.50%. It is, therefore, recommended that a good quality SBSMS could be prepared by using 1.25% spice mix to buffalo skim milk chhana along with other necessary ingredients.

The scores for different sensory attributes of smoked buffalo skim milk sausage (SBSMS) prepared by separately adding common salt at 1.00 (i) and 1.50% (ii) levels and their ANOVA are presented in Table 9 and 10, respectively. According to ANOVA, level of common salt significantly (p<0.05) affected body and texture (BT) and highly significantly (p<0.01) influenced flavour as well as overall acceptability (OA) of the product. Colour and appearance (CA) of SBSMS was not affected significantly (p>0.05) by the common salt levels. Table 8 indicates that highest score for flavour, BT as well as OA were obtained by sample (i), while sample (ii) scored highest for CA. This indicates that sample (i) was more acceptable to the judges than sample (ii). Addition of 1.50% of common salt might have caused distinct saltiness in the sample while a level of 1.00% of common salt might have proved to be optimum. Sodium chloride is widely used in many dairy products such as different varieties of cheese, butter etc. to obtain desirable sensory properties and inhibit microbial growth in the product. Fahim *et al.,* (1982) [4] reported extension in shelf life of raw milk due to addition of sodium chloride. Buffalo milk performed better than cow milk in this regard. According to Yadav *et al.,* (1994) [11], addition of common salt to milk during the manufacture of low fat paneer from buffalo milk improved the body and textural characteristics and yield of the product besides enhancing the shelf life at room temperature. Based on results obtained in the present investigation, it could be concluded that addition of 1% of common salt to the buffalo skim milk chhana proved to be better than 1.5% for production of SBSMS.

Table 1: Effect of fat level in buffalo milk on the sensory quality of smoked buffalo milk sausage (Mean±SE)

Fat% in buffalo milk	Sensory scores of smoked buffalo milk sausage			
	Colour& Appearance	Flavour	Body & Texture	Overall Acceptability
0.5	7.15±.19	7.25±.14	6.60±.13	7.10±.15
2.0	7.05±.18	7.10±.16	6.90±.16	7.05±.15
3.5	7.67±.20	7.65±.16	7.72±.16	7.85±.15

Table 2: Analysis of variance for the effect of levels of fat in buffalo milk on the sensory quality of smoked buffalo milk sausage

Attributes	Source of variance	
	Level of fat	Error
	MSS	MSS
Colour and appearance	2.25	0.76
Flavour	1.61*	0.49
Body and Texture	6.78**	0.48
Overall acceptability	4.01**	0.42

d.f.: level of fat = 2; Error= 57

*Significant (p<0.05); ** Significant (p<0.01)

Table 3: Effect of duration of smoking on the physico-chemical properties of buffalo skim milk sausage (Mean±SE)

Parameters (%)	Control	Duration of Smoking (min)		
		15	30	45
Yield	11.96±0.12	11.56±0.14	11.05±0.14	10.39±0.14
Moisture	60.62±0.28	58.42±0.31	56.61±0.35	54.76±0.33
Fat	3.21±0.06	3.29±0.07	3.38±0.06	3.49±0.06
Protein	31.61±0.32	32.63±0.31	33.46±0.3	34.12±0.3
Ash	2.77±0.05	2.94±0.07	3.05±0.06	3.09±0.06
Titratable Acidity (% of lactic acid)	0.23±0.003	0.22±0.003	0.22±0.003	0.21±0.003

Table 4: Analysis of variance for the effect of duration of smoking on the physico-chemical properties of buffalo skim milk sausage.

Parameters	Source of variation	
	Level of smoke	Error
	MSS	MSS
Yield	6.85**	0.29
Moisture	94.35**	1.58
Fat	0.21*	0.06
Protein	17.15**	1.45
Ash	0.31**	0.05
Titratable Acidity	0.001**	0.00

d.f.: level of smoke = 3; Error= 56

* Significant (p<0.05); ** Significant (p<0.01)

Table 5: Effect of different duration of smoking on the sensory quality of buffalo skim milk sausage (Mean±SE)

Smoking time (min)	Mean sensory score			
	Colour& Appearance	Flavour	Body & Texture	Overall Acceptability
0	7.40±.11	7.75±.14	7.65±.10	7.55±.11
15	7.60±.11	7.80±.13	7.85±.16	7.90±.12
30	7.20±.17	7.20±.15	7.00±.16	7.10±.16
45	5.85±.15	6.05±.18	5.70±.12	5.70±.14

Table 6: Analysis of variance for the effect of different smoking time on the sensory quality of smoked buffalo skim milk sausage

Sensory Attributes	Source of variance	
	Smoking time	Error
	MSS	MSS
Colour and appearance	12.54**	0.386
Flavour	13.23**	0.488
Body and Texture	18.83**	0.412
Overall acceptability	18.64**	0.378

d.f.: level of smoking = 3; Error= 76; ** Significant (p<0.01)

Table 7: Effect of level of spice mix on the sensory quality of smoked buffalo skim milk sausage (Mean±SE)

Level of Spice mix (%)	sensory score			
	Colour& Appearance	Flavour	Body & Texture	Overall Acceptability
1	7.40±.11	6.65±.19	6.80±.17	6.85±.13
1.25	7.30±.15	7.60±.11	7.30±.14	7.60±.11
1.5	5.85±.15	6.05±.18	5.70±.12	5.70±.14

Table 8: Analysis of variance for the effect of different levels of spice mix on the sensory properties of smoked buffalo skim milk sausage.

Attributes	Source of variance	
	Level of spice mix	Error
	MSS	MSS
Colour and appearance	15.517**	0.38
Flavour	12.21**	0.56
Body and Texture	13.4**	0.45
Overall acceptability	18.41**	0.34

d.f.: level of spice mix = 2; Error= 57
** Significant (p<0.01)

Table 9: Effect of level of common salt on the sensory quality of smoked buffalo skim milk sausage (Mean±SE)

Level of salt (%)	Mean sensory score			
	Colour& Appearance	Flavour	Body & Texture	Overall Acceptability
1.0	7.30±.15	7.60±.11	7.30±.14	7.60±.11
1.5	7.40±.11	6.05±.18	6.80±.17	5.70±.14

Table 10: Analysis of variance for the effect of different levels of common salt on the sensory quality of smoked buffalo skim milk sausage.

Attributes	Source of variance	
	Level of spice mix	Error
	MSS	MSS
Colour and appearance	15.517**	0.38
Flavour	12.21**	0.56
Body and Texture	13.4**	0.45
Overall acceptability	18.41**	0.34

d.f.: level of common salt = 2; Error= 57
** Significant (p<0.01)

Conclusions

It is concluded that a good quality smoked sausage from Buffalo skim milk could be prepared by heating the skim milk (0.5% fat) to 90 ºC without holding, cooling to 70 ºC, coagulating the milk by adding 1% citric acid solution, removal of whey through filtration, adding 1.25% and 1% of spice mix and common salt, respectively to the skim milk chhana, mixing the ingredients thoroughly followed by smoking of the contents for 15 min and stuffing in artificial cellulose acetate casings. Smoked buffalo milk sausage made from 3.5% fat milkwas better when compared with those prepared from 0.5 and 2.0% fat buffalo milk. Incorporation of 1.25% spice mix produced best quality smoked buffalo skim milk sausage as compared to those made by separately mixing 1 and 1.5% spice mix. Addition of 1% common salt to buffalo skim milk chhana along with other necessary ingredients followed by smoking for 15min and stuffing in artificial cellulose acetate casings gave a better smoked buffalo skim milk sausage than that prepared by adding 1.5% of common salt.

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