Quality evaluation of low fat milk slice prepared with 1.5 % fat corrected milk coagulum and sorghum millet flour

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ABSTRACT

Milk is rich in vital nutrients and health enhancing components. Today’s health conscious consumer is looking for high dietary fiber, protein rich and low fat food products. The present study was conducted with an objective to develop Ready to eat low fat milk slice and its quality evaluation. Preliminary experiments were conducted to standardize the basic formulation and processing conditions for the preparation of low fat milk slice using the coagulum prepared from 1.5 % fat corrected milk. In the next experiment, the Sorghum millet flour was incorporated in the developed formulation at three different levels viz 15, 25 and 35% separately. On the basis of results of sensory evaluations, 25% incorporation level was found to be optimum. This product was further studied for physico-chemical characteristics. Thus development of ready to eat low fat milk slices gives a healthy product along with the scope for efficient utilization of skim milk.

Key words: Low fat milk, Milk slices, Physico-chemical, Ready to eat (RTE), Sensory evaluation, Sorghum millet flour.

INTRODUCTION

Milk and milk products has long been a major constituent of our diet. These have long been central to diet in both developed and developing countries. Milk is highly nutritious food providing high quality proteins with almost all essential amino acids. Milk is widely accepted livestock product and enjoyed a special status in food culture of human societies worldwide. In India, milk is considered not only the source of nutrition but medicine as well in indigenous medicine. Milk is known for its nutritional and therapeutic values and other health benefits owing of bioactive peptides and short chain fatty acids. Milk is rich source of vitamins, minerals like calcium and phosphorus, fat and protein; however it lacks some critical component like iron and dietary fiber. Milk utilization pattern is dominated by liquid milk consumption (50%) followed by preparation of traditional milk products (45%). Only 5% of the total output is utilized to produce processed milk products. Use of liquid milk dominates the milk consumption pattern though sizable of milk is converted into other milk products. Diversification of product base can be improved with adding more functionality in food development endeavor. Sorghum (Sorghum bicolor L. Moench) is considered as a most important food crop in the world following wheat, rice, maize and barley (FAO, 1997). Grain sorghum represents the staple food for a large population of Africa, India and the semi-arid parts of the tropics (FAO, 1997). It is commonly consumed by the poor mass of many countries and forms a major source of proteins and calories in the diet of large segments of the population of India and Africa (FAO, 1997). Besides being a staple food, it is also used as feed for animals and it is an industrial raw material; its straws provide fodder, fuel, shelter and raw material for syrup production. Grain sorghum is the leading cereal crop and acts as a principal source of energy, protein, vitamins and minerals for the low income population (Ahmad et al., 2014). Presently, there is considerable interest in sorghum for food because of its photochemical content, nutritional potential and the possibility of use in gluten-free products (Taylor et al., 2014). Low digestibility of seed protein and starch of sorghum diminishes its nutritional value. Relatively lower protein content than starch (10% protein: 70% starch) affects the functional properties like gelatinization and digestion (Chandrasekhar and Kirleis, 1988). Number of exogenous and endogenous factors have been known for the poor digestibility of sorghum (Duodu et al., 2003) Despite a high degree of sequence homology to maize zein, kaffirin a unique storage protein, 70-80% of protein content of sorghum contain higher proportion of cross linked fractions responsible for difference in functional properties. Being more hydrophobic in nature kaffirin is less accessible to digestive enzymes (Wall and Paulis, 1978). In sorghum starch granule are largely polygonal, tightly packed and surrounded with spherical protein bodies. Very close association and

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interaction of starch and protein in sorghum influences the starch and protein digestibility due to limited access to enzymatic hydrolysis. Wet cooking of sorghum was found to increase the cross linking of protein results in poor digestibility. Sorghum has been consumed in various forms (Anglani, 1998) with increasing popularity in the form of snacks, cookies and ethnic food (Awika and Rooney, 2004). 70% of the total sorghum produced in India is consumed as unleavened flat bread (Murthy and Subramanian, 1981). Demand for dairy products is influenced by dietary preferences, socio-economic and other demographic factors. Research and development efforts for diversification of dairy products with emphasis on neutraceuticals and functional foods represent newer opportunities for creating niche market (NAAS, 2003). Growing awareness regarding health concerns among consumers along with appearance of more scientific communications regarding diet and health has paved the way for neutraceuticals and functional food segment of food sector. Dietary fat is needed as a metabolic energy source and a supplier of essential nutrients, but it must be consumed in moderation for reasons of human health. There is growing evidence associating dietary fat (quantity and type of fat) with chronic disorders such as ischemic heart diseases, some types of cancer and obesity (WHO, 2003). Fat reduction has generally been seen as an important strategy to improve the fat content of foods and produce healthier products. Low-fat and fat-free milk and milk products are recommended as part of a healthy diet to reduce the risk of cardio vascular disease through the maintenance of healthy plasma lipids and lipoprotein cholesterol levels (Huth and Park, 2012.). Several epidemiological studies have found an association of low-fat dairy product intake with lower risk of type 2 diabetes in men and women (Margolis et al., 2011). Since last few decades the role of dietary fibers in health and nutrition has received considerable public attention. It includes reduced risk of coronary heart disease, diabetes, obesity, and some forms of colon cancer. Supplementation with dietary fiber can result in fitness-promoting foods, low in calories, cholesterol and fat. Most nutritionists and diet experts suggest that 20–30% of our daily fiber intake should come from soluble fiber. Dietary fiber can also impart some functional properties to foods, e.g., increase water holding capacity, oil holding capacity, emulsification and/or gel formation. It can even modify textural properties; avoid syneresis (the separation of liquid from a gel caused by contraction), stabilize high fat food and emulsions, and improve Shelf-life. Deficiency of dietary fiber, iron and lysine can be well addressed by incorporation of cereals, fruits and other plant edibles. Compatibility of milk with cereals has given rise the range of cuisine and desserts in Indian food culture. Consumption of cereals based milk products is very popular in India e.g. kheer or pysum. Product diversification is one of the important research and development activity for sustainability of the food processing sector. More than 1.2 billion population with great cultural diversity offer opportunities for innovation in food products (Singh et al., 2011.). Milk slice, a new variety of convenience emulsion based dairy product which may be tried as adjunct to breakfast or as such. In view of above facts, the present research study was conducted with an aim of development and quality evaluation of ready to eat low fat milk slices extended with sorghum flour.

MATERIALS AND METHODS

Milk: Milk for pursuing this study was procured from the Dairy Technology Section of Indian Veterinary Research Institute, Izatnagar, Bareilly (U.P.). The procured milk was pasteurized one with combination of cow and buffalo milk as per daily production at dairy farm. Skim milk used in this study was prepared by separating the cream using a hand-driven centrifugal cream separator and fat content in required milk was standardized with skimmed milk using Pearson square method.

Chemicals and ingredients: Chemicals of analytical and food grade were purchased from standard firms (Hi-media, Qualigenes, Merck etc.). Other ingredients like refined wheat flour, sorghum flour, sugar, spices, and condiments etc. were procured from the local market.

Experimental details: In preliminary experiments, different processes and formulations were tried to prepare an acceptable quality ready to eat low fat milk slice (Fig 1). On the basis of preliminary findings, formulation was standardized in terms of amount of milk coagulum, binders, spices and condiments. Dough was prepared in mixer with prior standardization of mixing time, batter consistency, cooking time and chilling time.

Analytical procedures: Cooking yield was determined by dividing the cooked product weight by the raw uncooked weight and multiplying it by 100 and expressed as percentage.

Blending of milk coagulum in mixer (2-3 minutes)
Addition of binders, spices and condiments
Continue blending for another 2- 3 minutes
Moulded in barrel shape container
Steam cooking for 30 min
Cooling and keeping overnight in refrigerator
Slicing
Sensory evaluation and sample analysis

Fig 1: Flow diagram for preparation of milk slices.
The pH of the homogenate was recorded by immersing a combined glass electrode of a digital pH meter (EL 68 of ELICO) Model LI-120 (Trout et al., 1992.).

The moisture, protein, fat and ash contents of milk nuggets were determined by standard methods using hot air oven, Kjeldahl assembly, Soxhlet extraction apparatus and muffle furnace respectively as per AOAC (AOAC, 1995.). Sensory evaluation of milk slices was conducted by the method used by (Rajkumar et al., 2010) using nine point descriptive scale, where 9=excellent and 1=extremely poor. The experienced panel consisting of scientists and Post Graduate students of the Division of Livestock Products Technology, IVRI, Izatnagar evaluated the samples. The panelists were briefed with the nature of the experiments without disclosing the identity of the samples and were requested to rate them on a nine point descriptive scale on the sensory evaluation pro-forma for different attributes. The product was warmed for 10-15 seconds and served to the panelists. Water was provided to rinse the mouth between tasting of each sample. The panelists evaluated the samples for attributes such as appearance, flavor, body and texture, juiciness and overall acceptability.

Statistical analysis: Data generated from various trials under each experiment were pooled and compiled as per the standard statistical methods (Snedecor and Cochran, 1995). The data were subjected to analysis of variance.

RESULTS AND DISCUSSION
Optimization of the incorporation level of sorghum in low fat milk slices: This study was conducted to optimize the level of sorghum flour (SF) for the preparation of low fat milk slices. SF (1:1 hydration, w/w) was incorporated at the level of 15%, 25% and 35% by replacing the milk coagulum in pre standardized lower fat milk slices formulation. Physico-chemical characteristics such as product yield, pH, moisture content, protein content, fat content and ash content and sensory attributes viz., appearance, flavor, body and texture, Binding, juiciness, milk flavor intensity and overall acceptability were evaluated to select the Optimum level of incorporation.

Physico-chemical characteristics: The Mean±SE for various physico-chemical characteristics of ready to eat low fat milk slices extended with different levels of sorghum flour (1:1 hydration, w/w) are presented in Table 1. ANOVA revealed that incorporation of different levels of sorghum flour in the formulation had highly significant effect (p<0.01) on product yield, pH, moisture content, protein content, fat content and ash content of the ready to eat milk slices. The mean product yield ranged from 93.91±0.10% for control product to 96.59±0.36% for the product with 35% SF. Further, the replacement of milk coagulum with SF at increasing level showed an increase in product yield. Further, there was no significant (p>0.05) difference between the product yield of control product with 15% FF and between the product yield of products with 25% and 35% SF. The increase in product yield with increasing incorporation level of SF may be due to the higher starch component of SF. The mean value of pH ranged from 6.13±0.02 for control product to 6.31±0.02 for the product with 35% SF. There was no significant (p>0.05) difference observed between pH of control and product with 15% SF, between products with 15% and 25% SF and between products with 25% and 35% SF. There was decreasing trend observed in pH with the increase in SF incorporation. This might be due to replacement of acidic milk coagulum with

Table 1: Physico-chemical characteristics of milk slices prepared with different levels of sorghum flour (SF) incorporation (Mean±SE)*.

| Products | Physico-chemical characteristics |
|----------|----------------------------------|
|          | Product Yield (%) | pH | Moisture (%) | Protein (%) | Fat (%) | Ash (%) |
| C1       | 93.91±0.11^a | 6.13±0.02^b | 55.8±0.21^c | 22.28±0.12^b | 7.21±0.08^a | 3.50±0.01^a |
| T1       | 94.34±0.09^b | 6.20±0.02^b | 56.60±0.33^b | 17.37±0.31^b | 6.07±0.13^b | 3.02±0.16^b |
| T2       | 94.70±0.10^b | 6.27±0.02^b | 57.08±0.26^b | 16.9±0.12^b | 6.03±0.10^b | 2.51±0.10^b |
| T3       | 96.59±0.36^b | 6.31±0.02^a | 57.49±0.42^a | 15.15±0.11^b | 5.22±0.15^b | 2.13±0.27^b |

Mean±SE with different superscript in a column differs significantly (p<0.05); n=6 for each treatment Control: without SF, T1: with 15% SF, T2: with 25% SF, T3: with 35% SF

Table 2: Sensory attributes of milk slices prepared with different levels of sorghum flour (SF) incorporation (Mean±SE)*.

| Products | Sensory attributes |
|----------|-------------------|
|          | Appearance | Flavour | Body and Texture | Binding | Juiciness | Milk flavor intensity | Overall acceptability |
| C1       | 7.38±0.09^a | 7.19±0.07^a | 7.15±0.05^a | 7.30±0.09^a | 7.16±0.06^a | 7.28±0.10^a | 7.31±0.08^a |
| T1       | 7.24±0.09^a | 7.06±0.11^a | 7.05±0.06^a | 7.05±0.08^a | 6.82±0.1^b | 6.98±0.06^b | 7.1±0.04^a |
| T2       | 7.13±0.05^b | 7.09±0.06^b | 7.11±0.07^a | 7.12±0.05^a | 6.97±0.08^b | 6.89±0.09^b | 7.11±0.07^a |
| T3       | 6.88±0.11^b | 6.67±0.10^b | 6.63±0.11^b | 6.70±0.11^b | 6.52±0.09^b | 6.5±0.09^b | 6.56±0.09^b |

Mean±SE with different superscript row wise differs significantly (p<0.05); n=21 for each treatment Control: without SF, T1: with 15% SF, T2: with 25% SF, T3: with 35% SF
millet flour which is somewhat basic in nature. The mean moisture content ranged from 55.8±0.21% in control to 57.49±0.42% in product with 35% FF. Further, there was no significant (p>0.05) difference in the moisture content among all the three treatment products and between control product and the products with 15% FF. Increase in starch component may have caused the increasing trend in moisture. The mean protein content ranged from 15.15±0.11% in milk slices with 35% SF to 22.28±0.12% for control milk slices. Protein content of control was significantly (p<0.05) higher than that of all sorghum incorporated milk slices. However, there was no significant difference observed between protein content of 15% and 25% SF. Protein content reduced significantly (p<0.05) with the increasing level of SF incorporation in the formulation. This was due to the decrease in coagulum amount with the increased replacement. The mean value of fat content ranged from 5.22±0.15% in the product with 35% SF incorporation to 7.21±0.08 in control product. There was no significant difference between the fat content of products with 15% and 25% SF. Further, a significant (p<0.05) reduction in fat content was observed with the increased level of SF replacing the coagulum. The mean ash content ranged from 2.13±0.27% in product with 35% SF to 3.50±0.00% in control product. Ash content was found to have a decreasing trend with increased SF incorporation replacing the coagulum, which is high in calcium and phosphorus content. However, there was no significant difference observed between the ash content of control and product with 15% SF and between the products with 25% and 35% SF.

Sensory attributes: The mean ±SE for various sensory attributes of milk slices incorporated with various levels of SF (1:1 hydration, w/w) are presented in Table 2. ANOVA revealed that incorporation of different level of sorghum flour in the formulation had highly significant (p<0.01) effect on all the evaluated sensory attributes. Mean appearance score ranged from 6.88±0.11 for the product with 35% SF to 7.38±0.09 for control product. Appearance scores of control and products with 15% and 25% SF were comparable. Further, the mean score of product with 35% SF was comparable with that of 25% SF and significantly (p<0.05) lower than the product with 15% SF. The mean flavour score ranged from 6.67±0.10 for the product with 35% SF to 7.19±0.07 for the control product. Flavour scores of the control product and the products with 15% and 25% SF were comparable. Further, the score of product with 35% SF was significantly (p<0.05) lower than the control and other two treatment products. The mean score for body and texture ranged from 6.63±0.11 for milk slices with 35% SF to 7.15±0.05 for the control product. Body and texture scores of the control product and the products with 15% and 25% SF were comparable. Further, the score of product with 35% SF was significantly (p<0.05) lower than the control and other two treatment products. Mean score for binding ranged from 6.70±0.11 for the product with 35% SF to 7.30±0.09 for control product. Binding scores of the control product and products with 15% and 25% SF were comparable while, the score of product with 35% SF was significantly (p<0.05) lower than other three products. Mean score for juiciness ranged from 6.52±0.09 for the product with 35% SF to 7.16±0.06 for the control product. The juiciness scores of control and product with 15% SF were comparable and the scores of the products with 15% and 25% SF were also comparable. However, the product with 35% SF incorporation level had significantly (p<0.05) lower score than all the other three products. The mean score for milk flavour intensity ranged from 6.50±0.09 for the product with 35% SF to 7.28±0.10 for control product. The treatment products had significantly lower scores than the control, however, there was no significant (p>0.05) difference between the scores of products with 15% SF and 25% SF. The product with 35% SF incorporation showed the significantly lowest milk flavor intensity score. The decrease in scores with increase in SF incorporation is due to the lower amount of milk coagulum in formulation resulted due to its replacement with SF. Mean score for overall acceptability ranged from 6.56±0.09 for the product with 35% SF to 7.31±0.08 for the control product. Overall acceptability scores of the control product and the products with 15% and 25% SF were comparable. Further, the score of the product with 35% SF was the significantly (p<0.01) lowest.

CONCLUSION
On the basis of the conducted research study, this may be concluded that ready to eat low fat milk slices with good to very good acceptability can be prepared with the use of coagulum from 1.5% fat corrected milk and on the basis of sensory scores and physico-chemical characteristics, the optimum incorporation level of sorghum flour was adjudged as 25%.

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