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Development and quality evaluation of whey-pearl millet based fermented beverage

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Abstract
Fermented milk products is in high demand because of their known health benefits and are becoming major part of milk product in Indian dairy market. The objective of the present study was to develop whey-pearl millet based lassi using standardized and neutralized whey and germinated pearl millet slurry. The form of cereal processing was selected from previous experiment. Whey pearl millet lassi was prepared by blending neutralized and standardized whey with germinated pearl millet slurry (milk in case of control) before fermentation. The developed lassi samples and control samples were analyzed for chemical composition (fat, protein, carbohydrate, ash, total solids and fiber) for estimating its nutritional content as well as for physico-chemical properties such as pH, acidity, viscosity, tyrosine, free fatty acids and wheying off. Under the present study, selected whey-pearl millets based curd had texture profile similar to control curd. The panelists rated 'whey-pearl millet (pearl millet and moth bean) lassi' as "liked very much" on nine point hedonic scale.

Keywords: Development, evaluation, whey-pearl, millet, beverage

Introduction

There is unlimited scope for growth and innovation in fermented milk products due to great demand by the consumers. Ever-growing consumer demand for convenience, combined with a healthy diet and preference for natural ingredients has led to a growth in functional beverage markets. There are more than 3500 traditional, fermented foods worldwide (EUFIC, 1999) [10]. St-Onge *et al.* (2000) [24] proposed as contributing mechanisms to the association of fermented milk consumption with decreased circulating cholesterol concentrations. The demand for fermented milk products is increasing and it has been estimated that about 10% of total milk produced in India is used for preparation of traditional fermented milk products. Fermented foods are valued as major dietary constituents in numerous developing countries because of they have more shelf life under ambient conditions - thereby contributing to food security - and because they add value, enhance nutritional quality and digestibility, improve food safety, and are traditionally acceptable and accessible (Holzapfel, 2002; Rolle and Satin, 2002) [15, 21]. According to Dhankher and Chauhan (1987) [8] and Kurmann *et al.* (1992) [18] rabadi is commonly used by low and average income rural populations in the millet producing regions. It is important staple food for millions of Indians. Singh *et al*. (2015) [23] summarized that the protein concentration increased and the amino acid profile is balanced by germination and fermentation. Consumption of milk containing cells of *L. acidophilus* can improve lactose indigestion in humans classified as "lactose maldigestors" (Kim and Gilliland, 1983) [17].

Materials and methods

The basic ingredients like skim milk powder (SMP) of Nova brand, pearl millet, cumin, black pepper and salt, glass bottles of 200 ml capacity were obtained from the local market. Paneer whey, standardized milk (4.5% fat & 8.5% SNF) and cream was obtained from the Livestock Products Technology Department, LUVAS, Hisar. Two mesophillic mixed strain culture i.e. NCDC-167 (*Lactococcus lactis* ssp. *lactis*, *Lactococcus lactis* ssp. *cremoris* and *Lactococcus lactis* ssp. *lactis* biovar. *diactetylactis* in 1:1:1 ratio) was obtained from National NDRI, Karnal. Pectin (degree of esterification 68-70 per cent) and Nisin used were of Hi Media Laboratories Pvt. Ltd 23, Vadhani Ind, Est., LBS Marg, Mumbai-400086, and India.

Preparation of pearl millets and whey

Pearl millets were used in the form of slurry of germinated grains in water, prepared by grinding.

pH of filtered whey was adjusted to 6.8±0.2 by using sodium bicarbonate (@0.5gm/100ml of whey) and then standardized to 4 per cent fat and 18 per cent total solids level by means of fresh cream and skim milk powder and then kept in refrigerator till further use.

Preparation of control

Pearl millet control lassi was prepared in accordance with procedure developed by Modha and Pal (2011) [19] using standardized milk with some modifications.

Standardized milk (500ml) was heated to 40 °C and pearl millet solids (pearl millet and moth bean slurry separately) @ 5% of base material were added. This mixture was then further heated to 90 °C for 5 min and cooled to 37 °C. It was then inoculated with starter culture at 3% followed by incubation at 37 °C for 6-8 h. The contents was blended with salt (0.85%), cumin (0.285%) and black pepper (0.05%) with the help of electric mixer and the cooled to 5 °C and stored in refrigerator (5–7 °C) for 2 hours before offered for sensory evaluation (Stone *et al*. 1974).

Optimisation of whey-pearl millet beverage (Lassi)

In the same way, whey pearl millet beverage was prepared by substituting milk with neutralized and standardized whey and adding germinated pearl millet slurry, mixture was preheated to 40°C and and pectin @ 0.1 per cent of whey was added and then converted into whey - pearl millet beverage (Lassi).

Analysis

The germinated form of pearl millet was selected from the previous experiment for selection of form of cereal processing on the basis of sensory parameters and growth indicator data. So, depending upon the results, germinated form whey-cereal beverage was developed and further evaluated for Moisture content according to the method of AOAC (2007) [3]. The fat, crude protein and ash content were estimated as per AOAC (2005) [2]. The textural properties of curd samples were evaluated using Texture Analyser (TA.HD plus), Stable Micro Systems Ltd., Surrey, England with the Texture Exponent Program as per the procedure outlined by Bourne (1978) [5]. The final developed product was also analysed for physico-chemical characteristics i.e pH by pH meter, titrable acidity by AOAC (2007) [3], viscosity by Rheology International viscometer and wheying off.

Results and Discussion

Milk Composition

Analysis results indicated that it contained 4.5 fat per cent and 8.5 per cent solid non-fat.

Composition of whey

Fresh whey was assessed for its composition and results are depicted in table 1.

These observations are in accordance with the earlier findings of Gupta (2008) [12] who also observed 6.50 per cent total solids, 0.5 per cent fat, 0.4 per cent protein, 0.5 per cent ash and lactose 5 per cent. TA and pH observations were similar to Bund and Pandit (2005) [6] who also observed paneer whey titratable acidity ranges between 0.4-0.6, and pH ranges from 4.0-5.0 respectively.

Proximate composition of whey-pearl millet based fermented beverage (Lassi)

The control lassi samples had significantly high moisture and fat from standardized whey-germinated pearl millet slurry lassi (table 2). Protein and total fiber content of control lassi samples were found at par with experimental sample. Ash content was significantly

Table 1: Composition of whey

Parameters	Per cent
Moisture (%)	93.30
Total solids (%)	6.70
Lactose (%)*	4.88
Protein (%)	0.68
Fat (%)	0.65
Ash (%)	0.49

*Calculated by difference (T.S.-(Fat+Protein+Ash)

Highest in experimental samples. As per the study conducted by Inyang and Zakari, 2008, germination and fermentation augmented the protein, ash, crude fibre, phosphorus, calcium and iron levels of Fura samples and decreased the phytic acid levels significantly compared with control i.e. clean ungerminated. Higher content of protein was found in developed (22.64 per cent) than its control sample (16.25 per cent) which might be due to higher protein content of moth bean i.e. 23.2 g/100g as reported by Gopalan *et al.* (2000) [11] used as main ingredient in developed sample. Sudha *et al*., 2016 [25] observed 0.5% protein, 1.3% fat, 7.1% TS in optimized fermented millet sprout milk beverage.

Table 2: Proximate composition of whey- pearl millet based fermented beverage (Lassi)

Constituents (%)	Pearl millets	
	Pearl millet	
	Control	Experimental
Moisture	90.20±0.09[b]	87.20±0.09[a]
Fat	3.82±0.01[b]	3.52±0.01[a]
Protein	3.09±0.01	3.06±0.01
Ash	0.93±0.01[a]	1.03±0.01[b]
Total Fibre	0.43±0.01	0.43±0.01

Mean ± SD, n=6

Means with different superscripts in a row differ significantly (*P*≤ 0.05)

Physico-chemical properties of developed whey-pearl millet based fermented beverage (Lassi)

Control beverage had shown pH value at par with whey-germinated pearl millet based lassi (table 3). Titrable acidity results had shown reverse trend to pH. While titrable acidity value were at par in case of whey-germinated pearl millet based lassi and control sample. Arora *et al.* (2009) [4] also observed significant drop in pH with corresponding increase in titrable acidity in germinated + autoclaved + fermented food mixture as compared to non-germinated food mixtures.

Table 3: Physico-chemical properties of whey- pearl millet based fermented beverage (Lassi)

Physico-chemical properties	Experimental	Control
pH	4.49±0.04	4.46±0.03
TA	0.71±0.08	0.73±0.07
Tyrosine(µg/ml)	60.00±0.89	59.55±0.79
Viscosity(cP)	36.60±0.25	37.00±0.21
FFA(µg/g)	0.466 ± 0.01	0.47± 0.02
Wheying off (%)	NIL	NIL

Mean ± SD, n=6

Means with different superscripts in a row differ significantly (*P*≤ 0.05)

Tyrosine value in control sample at par with whey-germinated pearl millet based lassi. Results revealed that proteolytic activity was highest in control which was at par with malted pearl millet sample which may be due to increase in protein in whey-germinated pearl millet during malting. Results are in close concord with Hassan *et al.* (2006) [13] reported that germination followed by fermentation was more effective in increasing protein digestibility of pearl millet. Chaudhary *et al*., 2016 [7] observed that the protein content of standard and 24 hr germinated samples was analyzed to be 11.5g/100g and 15.46 g/100g; however, in 36 h germinated sample the values were 17.1g/100g and 21.8g/100g after 48 hrs. The high proteolytic activity during germination leads to an increase in the protein solubility resulting from hydrolysis of the storage proteins in germinated sorghum flours (Elkhalifa *et al.*, 2010) [9]. Similar results were reported for viscosity, free fatty acid and wheying off in both the control as well as whey germinated pearl millet lassi (experimental)

Texture profile analysis of curd of whey-pearl millet (Pearl millet and moth bean) based fermented beverage (Lassi)

The texture profile analysis (TPA) was carried out and results are presented in table 4.

The evaluation of texture profile analysis (TPA) curd revealed that hardness, adhesiveness, cohesiveness and gumminess of the standardized whey-germinated pearl millet slurry curd was at par with control curd sample. Present study results are not in agreement with the previous study on soy yogurt, this may be due to harder texture of soy product. In a similar type of study on probiotic soy yogurt prepared from germinated soybean, Yang and Li (2010) [26] found values for hardness (N); hardness 16.03 - 26.71/g, adhesiveness (g.s) 31.14 to 71.77, springiness (mm) 0.95 to 0.99, cohesiveness 0.44 - 0.46, gumminess 7.38 - 12.15 of sogurts.

Table 4: Texture profile analysis of curd of whey-pearl millet (Pearl millet) based fermented beverage (lassi)

Texture parameters	Pearl millet	
	Control	Experimental
Hardness(N)	0.28±0.01	0.26±0.09
Adhesiveness(N×mm)	1.67±0.03	1.65±0.11
Cohesiveness	0.72±0.05	0.70±0.02
Gumminess(N)	0.20±0.07	0.18±0.04

Mean ± SD, n=6

Means with different superscripts in a row differ significantly ($P \leq 0.05$)

The structure of the protein network in yoghurt, which depends on the protein content, heat treatment of the bulk milk, fat content, thickening agents and bacterial exopolysaccharides, is responsible for hardness and cohesiveness, whereas ropiness contributes to adhesiveness (Hess *et al*., 1997) [14].

Conclusions

Today, the consumer's demand for the products with functional properties which led to the promotion of added-value products such as probiotic and other functional yoghurts, reduced-fat and enriched milk products and fermented dairy drinks and organic cheese (Rudrello, 2004) [22]. The food industries are looking for ingredients, which can provide good functional and nutritional properties for formulation of various value-added food products. There are sufficient scientific and clinical confirmation which is increasing consumer perception for fermented milks. Therefore, to make the best use of dairy whey and low cost grains, the present study was proposed to develop delicious and nutritious traditional pearl millets based fermented dairy products from the combinations of whey, skim milk powder, and low cost grains. Considering all the points, the present work was planned to develop whey pearl millet based fermented dairy products. Texture profile study indicated that curd set by using whey-pearl millets slurry base had texture profile similar to control curd.

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