Development of Beverages from Traditional Whey and Natural Fruit Juices

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Abstract

Improving sensorial and nutritional quality of traditional whey is one of the areas to maximize its utilization and ensure food and nutrition security in the country. The juices of mango, orange, pineapple and papaya fruits were blended with traditional whey at 100/0, 90/10, 85/15, 80/20 and 75/25 to fruit ratios to develop nutritious beverages. Sensory evaluation was conducted for all the twenty treatment combinations (4 fruits x5 ratios) and the result was used to select acceptable treatments for further chemical and microbial analysis. Results of the experiment showed that fruit flavored beverages scored higher values than the control (100% traditional whey) for all sensory attributes indicating the potential of natural fruit juices in enhancing the acceptance of traditional whey. It was observed that addition of 15 to 25% mango and pineapple juices improved sensory property and nutritional quality of traditional whey. Therefore, this practice can be applied to enhance utilization of traditional whey, which otherwise be wasted and ensure nutrition security at household level. However, large scale demonstrations should be carried out for wider adoption and issues related to shelf life and packing technology be addressed for further commercialization of these results.

Introduction

Whey is a natural and very dilute byproduct of cheese making process and represents 20% of the protein found in dairy milk (William and Emeritus, 2008).Whey contains water soluble vitamins, minerals mainly calcium and phosphorus, essential amino acids, lactose, fat, 6-7% total solids, albumin and globulins (Parekh, 1997; Mazaheri, 2008). It contains all the constituents of milk fat and fat-soluble vitamins (Horton, 1995). Product development using whey can be used as an excellent source of quality protein for developing countries (Chatterjee *et al*., 2015). Beverages made up of fruits and milk products are currently receiving considerable attention as their market potential is growing due to their nutritious value and deliciousness (Sakhale *et al*, 2012).

In Ethiopia, the amount of whey produced is not well quantified. By considering the amount of butter, buttermilk produced and the resultant whey as a byproduct, it is estimated to be very high (Mazaheri, 2008). At smallholder farmers' level, whey is either discarded or provided to cows and pet animals such as dogs. Besides, whey produced by dairy cooperative unions is discarded. Moreover, it is becoming one of the potential sources for environmental contamination during cottage type cheese making

operations. According to a report by Ryan *et al.* (2012), whey is a highly pollutant dairy waste, disposal of which represents a serious environmental pollution, and as a result many dairy organizations treat whey before disposal (Gandhi, 1989). Use of whey as a food ingredient can avoid or reduce the environmental pollution and save losses of nutrients that would have been wasted (Khedkar et *al.*, 2014). To this end, it is behaved that developing technologies applicable at smallholder farmers' level for the efficient utilization of whey may have critical role to solve the problem associated with nutritional security.Therefore, this experiment was designed to develop nutritious beverages by blending traditional whey with natural fruit juices.

Materials and Methods

Preparation of traditional whey

Bulkcow milk was collected from Holetta Agricultural Research Center dairy farm kept in a clean container and left aside for three days for spontaneous fermentation without addition of any starter culture. Then the fermented and coagulated milk was churned and butter was removed, and the remaining part was heated at 85°C until the cheese coagulated. Finally, the cottage cheese was separated from the whey by filtering using muslin cloth and the whey was kept in a labeled clean container.

Preparation of fruit juices

Fresh and healthy orange, papaya, mango and pineapple fruits were purchased from the surrounding fruit shops at Holetta town. The fruits were thoroughly washed and peeled, seeds and outer coverage (pulps) were removed and flesh parts cut into pieces. Finally, juices were prepared using juice blender and each fruit juice was separately kept in a labeled clean container.

Formulation and treatment set up

Beverages were prepared from juices of each of the four fruits (mango, orange, pineapple and papaya) blended with the traditional whey at four fruit juice to whey ratio (0:100, 10:90, 15:85, 20:80 and 25:75). In all the treatments 5% sugar was added and homogenized. Sensory evaluation was conducted for all the twenty treatments (4 juice types x 5 juice to whey ratios) and the result was used to select acceptable treatments for further chemical and microbial analysis.

Sensory Evaluation

Beverages prepared from whey and fruits blends were subjected to a sensory evaluation following the method of Santiago *et al.* (2012). A total of ten semi-trained panelists, consisting of food science and microbiology researchers, and other staff members of Holetta Agricultural Research Center, who have knowledge in sensory analysis were selected for the evaluation.Training was given to panelists about the beverages and each attributes to be considered in the evaluation. A 5-point hedonic scale, where 5 standards for like very much and 1for dislike too much was used to score each sensory attribute.The attributes considered for evaluation were color, taste, flavor, sourness and overall acceptability.

Chemical analysis

Determination of fat content: Gerber method was used to determine the fat content of the blended whey samples. The beverage samples were kept at 37^0 C for 30 minutes in a water bath to warm back the samples to normal body temperature of a cow. Ten ml of concentrated sulphuric acid, 11 ml of fruit blended whey beverage and one ml of amyl alcohol were added into a butyrometer. The butyrometer stopper was put on and the sample was shaken and inverted several times until all the milk was digested by the acid. Then, the butyrometer was placed in a water bath at 65^0C for five minutes. The sample was placed in a Gerber centrifuge for four minutes at 1100 rpm (rotations per minute). Finally, the sample was placed in to a water bath at 65^0C for 5 minutes and fat percentage was read from the butyrometer (O'Connor, 1994).

Determination of protein content: Formaldehyde titration method was used to determine the total protein content of the samples. Ten ml of fruit blended whey beverage was added into a beaker. Then, 0.5 ml of 0.5 % phenolphthalein indicator and 0.4 ml of 0.4 percent Potassium Oxalate were added into the sample and titrated using digital dispenser/burette with 0.1N Sodium Hydroxide solution. The titration was continued until pink color become intense and the reading was multiplied by a factor 1.74 (O'Connor, 1994).

Determination of total solids: Three grams of the blended whey beverage sample was pipette in pre-weighed and dried crucibles. The crucibles were placed on a boiling water bath for 30 minutes. The samples were dried in an oven at 102°C for 14 hours. Then, the dried samples were placed in a desiccator to cool and weighed. The samples were dried again in the oven for 1 hour as before cooled and reweighed. The drying process was repeated until the difference in weight between two successive readings was not more than 1 mg just to determine the amount of total solids (O'Connor, 1994).

Determination of ash content: Total ash was determined gravimetrically by igniting the dried mixture of whey beverage samples that were used for total solids determination. The samples were put in a muffle furnace where the temperature was slowly raised to 550^0C until five hours. The sample was ignited until carbon (black color) disappeared or until the ash residue become white. Finally, the ash was removed from the furnace, cooled in desiccators and its proportion in each sample was calculated.

Determination of lactose: Percent lactose of the beverages was determined by subtracting percent fat, protein and ash from the total solids content, where % Lactose = Percent total solids - (% fat+ % protein+ % total ash).

Determination of titratable acidity: TitratableAcidity was measured by titrating 10 ml of sample with N/9 NaOH to a phenolphthalein end (O'Connor, 1994).

Determination of P^H: The pH of samples was determined by using digital pH meter, which was calibrated against standard buffer upon use each time.

Microbial Analysis

Determination of aerobic mesophilic bacteria: Plate count agar (PCA) media was autoclaved at 121^0C for 15 minutes and cooled in a water bath adjusted at 45^0C. Appropriate decimal dilutions of the beverage samples (0.1ml) were mixed with 20 ml of plate agar medium in duplicates and promptly incubated for 48 hours at 35^0C. Finally, the duplicate petri dishes having 30 - 250 colonies were manually counted (FAO, 1997; Michael and Joseph, 2004).

Determination of total coliforms: Violate Red Bile Agar (VRBA) media was boiled on a slow heating stove and tempered in water bath at 45^0C. Then, 0.1ml of appropriate decimal dilutions of the beverage sample was poured on petri dishes in duplicates and mixed with 20 ml of VRBA per dish. The petri dishes with solidified agar medium were inverted and incubated at 32^0C for 24 hours, after which total coliforms having 15- 150 dark red colonies and measuring at least 0.5 mm in diameter were manually counted in each petri dish (FAO, 1997; Michael and Joseph, 2004).

Yeast and molds: Potato Dextrose Agar (PDA) media was autoclaved at 121^0C for 15 minutes and tempered in water bath adjusted at 45^0C. Appropriate decimal dilutions of beverage samples (0.1ml) were poured on 15 x 90 ml petri dishes, mixed with 20 ml of PDA containing chloramphenicol, and incubated at 25^0C for 5 days. Finally, yeast and molds with plates containing 10 -150 colonies were manually counted (FAO, 1997; Michael and Joseph, 2004).

S**tatistical analysis**

The microbial data were transformed to log 10 prior to analysis. Both the chemical composition data and log transformed microbial counts were analyzed using General Linear Model (GLM) of the Statistical Analysis System (SAS). Least Significant Difference (LSD) test at 5% probability ($p<0.05$) level was used to compare the means (SAS, 2001). Data for the sensory properties of the blended whey beverages were analyzed using descriptive statistics.

Results and Discussion

Sensory evaluation

It was observed that all the sensory attributes had higher values for whey blended beverages than for the control (100% traditional whey), indicating the potential of natural fruit juices in enhancing the acceptance of traditional whey. Overall acceptability was higher for whey than pineapple proportion of 75:25 and whey to mango proportion of 75:25, 80:20 and 85:15. Sourness of the beverages increased with increasing proportion of mango juice in the blends while flavor improved with increasing proportion of pineapple juice. On the other hand, addition of 15 to 25% mango juice to traditional whey considerably improved test of the beverage.

Chemical composition fresh beverages

Result of the initial chemical composition of traditional whey blended with pineapple and mango juice is presented in Table 1. The protein content observed in the current study was comparable to that of whole milk. Blending of traditional whey beverages with mango and pineapple juices enhances the protein content of the beverages particularly at the initial stage. Protein contents of 75% whey and 25% mango was significantly higher than other combinations of whey and fruits. This result was in agreement with the findings of Sherwood and Jenkins (2007) who reported that blended whey beverages contain high amount of protein with high nutritional value and ideal source of energy and nutrients. A report by Chatterjee *et al.* (2015) also indicated that whey based pineapple beverages with excellent nutritional and sensory properties could be an interesting product in the constantly growing market for functional foods. It has also reported that whey with fruit juice combinations showed promising trends in the manufacture of value added nutritious beverages (Parekh, 1997).

Means followed by the same letter(s) in a column are not significantly different at 5% P level.

Chemical composition of the beverages after 7 days of preservation

Result of chemical composition of traditional whey and fruit blends pasteurized at 80^0C for 15 minutes and preserved at 4^0C for 7 days is presented in Table 2. Mango and pineapple blending significantly, improved total solids, ash and lactose contents. Titratable acidity and pH contents were not significantly different for all blending proportions. In the present study, the whey proteins showed an increasing trend with 25% mango blend.

Means followed by the same letter(s) in a column are not significantly different at 5% P level.

Chemical composition of the beverage after 15 days of preservation

The result of chemical composition of traditional whey and fruit blends pasteurized at 80^0C for 15 minutes and preserved for 15 days at 4^0C is presented in Table 3. Except fat and total solids, all the other chemical parameters (protein, ash, lactose, titratable acidity and pH) of the beverages were not significantly ($P<0.05$) affected by blending proportions. The average total solids content of 100% traditional whey was significantly ($P<0.05$) lower than the three fruit blends.

Microbial properties of the whey beverages

Results of microbial load of traditional whey and fruit blends while it is fresh, after seven day preservation and 15 days preservation are presented in Table 4, 5 and 6, respectively. Preserved beverage samples were pasteurized at 80^0C for 15 minutes and kept at 4^0C. At fresh state, total bacterial counts, total coliforms, and yeast and molds were found to be significantly ($P<0.05$) affected by the blends (Table 4). Coliform, yeast and mold counts increased after storage. Total coliforms and yeast and mold load of preserved whey beverage samples showed no significant difference between treatments (Table 5 and 6).

Means followed by the same letter(s) in a column are not significantly different at 5% P level.

Means followed by the same letter in a column are not significantly different at 5% P level.

Means followed by the same letter(s) in a column are not significantly different at 5% P level, NS=non-significant

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