Improvement of Nutritive Value of Traditional Foods using Whey Produced from Heat Coagulated Cheese Type

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In order to enhance the nutritive value of traditional foods and test alternative utilization techniques, whey based porridge and bread were made from barley and wheat flour, respectively. Water and whey were used in the proportions of 100:0, 75:25, 50:50, 75:25 and 0:100 to prepare the porridge and bread. The protein, fat and ash contents of both bread and porridge increased with increasing proportion of whey in the blends. In sensory evaluation, acceptability of bread increased with increasing proportions of whey, whereas porridge with 25% whey had the highest acceptability. Hence, based on the nutritive value and sensory acceptability, 100% whey blended bread and 25% whey blended porridge could be recommended for further promotion at community level to address the existing problem of protein energy malnutrition.

Keywords: Whey, porridge, bread, nutritive value and sensory acceptability

The total annual milk production from 10 million milking cows is estimated at about 3.2 billion litres. This can be equated to an average production of 1.54 litres of milk/cow/day (CSA, 2008). Out of the total annual milk production 68.4% is used for home consumption mainly in rural areas; and only 14.6% is marketed and about 17% is reserved for suckling by calves. Apart from consumption of fresh whole milk, dairy products are widely used in traditional recipes in the form of butter/traditional ghee, butter milk (*ayib),* fermented milk (*Irgo)* and cottage gheese (Getachew and Asfaw, 2004).

Whey is produced as a by-product of cottage cheese (*ayib)* by heating butter milk (*arera)* in a clay pot or a similar material on a low fire to about 40-50^{o}C (Zelalem, 2010). When the curd and whey separate, the heating is stopped and the contents of the pot are allowed to cool and then the whey is drained off (FAO, 1990). According to Mazaheri (2008), whey represents 90% of the volume and 50% of the solids of milk used in the manufacture of cheese. The same author reported that whey represents about 85-95% of the milk volume used in the cheese-making industry.

Whey proteins represent about 20% of milk proteins and constitute a rich source of complete and bio-available amino acids. It is also excellent source of calcium, phosphorus, and vitamin D. On the other hand, a long term disposal of whey causes environmental pollution. Worldwide, considerable efforts have been made over the past years to find new avenues for whey utilization in many food products for the economic benefit of dairy industry and to utilize the valuable nutrients found in whey. For instance, incorporation of whey and whey components into a variety of foods to obtain whey based instant energy beverages, whey protein concentrates, and lactose powders (Ghaly *et al.,* 2004).

Whey and whey products are considered as appropriate ingredients for promoting nutritive value and organoleptic characteristics of many food products including bread and other bakery products (Rantamaki *et al*, 2006). Whey proteins are important functional component in bread and similar formulations. They enhance crust browning, crumb structure and flavor, improve toast qualities and retard staling (Salazar *et al*., 2017). Blending whey powder with haricot bean based weaning food had improved the protein, iron and fat contents from 7.9% to 13.94%, 1.14% to 3.02% and 1.12% to 1.95%, respectively (Mathewos and Shimelis, 2014).

Currently, consumers are demanding healthy diets and nutritional foods; these requirements have allowed a continuous growth on sales of functional foods. Food fortification is one of the major techniques used to create functional food products (Salazari *et. al.,* 2017). Incorporation of dairy ingredients into the dough improves the baking quality and can be more beneficial than chemical additives because of their high nutritional value and natural origin. Therefore, the objectives of this study were to develop and test alternative whey utilization techniques to enhance nutritive value of traditional foods, and to promote value addition in whey production and increase its contribution to food security.

The experiment was conducted in Holeta Agricultural Research Center dairy laboratory. In this study both whey breads and whey porridge were prepared by replacing full or part of the water during baking, and the proportions were 100% water, 25% whey and 75% water, 50% whey and 50% water, 75% whey and 25% water, and 100% whey.

Bulk cow milk was collected from Holeta 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 40-50^{0}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.

Refined wheat flour and yeast were bought from super market. The yeast was activated in Luke warm water for ten minutes before addition. Salt was dissolved in water before being added to the flour. Wheat flour was mixed with activated yeast, salt solution and formulated water/whey. Then kneaded, proved at 30^{o}C and RH75, and baked at 165^{o}C. The breads were kept in small dishes and labeled for identification purpose.

Barely grain was milled to flour, and a thick and consistent porridge was prepared from all the water and whey formulations by cooking with warm water and stirring until desired consistency was attained. The porridge was kept until it got cool to a mild temperature and served to panelists with plastic plates.

The prepared bread and porridge were subjected to sensory evaluations by 20 semi-trained panellists who had previous experience on evaluations of milk and milk products. The panellists evaluated the bread for five attributes namely color, taste, texture, appearance and overall acceptability.While, porridge was evaluated by its odour, taste, color, sourness and over all acceptability. Each panelist independently scored the samples and recorded the scores on the sheets provided using five-point hedonic scale (1= dislike extremely, 5= like extremely) (Santiago *et al*., 2012). The panelists were served with water to clean their mouth before and after tasting each sample (Bodyfelt *et al.*, 1988).

Titrable acidity: Titrable acidity (expressed as % lactic acid) of whey was determined by titration with 0.1N sodium hydroxide solution; using phenolphelthalein as indicator according to the procedure by O'Connor (1995).
Total solids (TS): TS of whey sample were measured by oven drying at 105°C until steady weight was achieved (approximately overnight) according to O'Connor (1995).

pH: The pH of the samples was determined by using digital pH meter; the pH meter was calibrated against standard buffer upon use each time.
Ash content: Ash content of the samples were measured gravimetrically by using dried portion of total solid in the muffle furnace by igniting at 550°C for 5 hours according to Standard Methods for the Examination of Dairy Products (Michael and Frank, 2004).

Fat content: Fat content of sample was measured by Gerber method according to the procedures by O' Connor (1995).

Protein content: The protein content of the sample was determined by using Formaldehyde titration method. 10 ml of whey was added into a beaker. Then, 0.5 ml of 0.5 % phenolphthalein indicator and 0.4 ml of 0.4 % Potassium Oxalate was added into the sample. Then, the sample was titrated using digital dispenser/burette with 0.1N Sodium Hydroxide solution. The titration was continued until pink color becomes intense and 2 ml of neutral 40% formalin which discharge the pink color was added. Then titrated with N/9 NaOH until a pink color of equal intensity was again obtained. Finally, the burette reading was recorded. The reading was multiplied by a factor 1.74 (O’Connor, 19945).

neither like nor dislike. This indicates that blending of whey in bread preparation improves the color quality of the bread as compared to bread prepared without whey. Similarly, the taste of 100% whey bread was rated the highest (4.6), whereas the taste of the bread without whey scored the lowest (3.0).

The highest average value of bread texture was obtained in the treatment proportion of 75% whey and 25% water rated 4.5, while the lowest average value of texture was obtained from treatment without whey bread rated 3. The highest average value of appearance was obtained in the treatment 100% whey bread rated 4.8 very close to like extremely. Whereas, the lowest average value of appearance was obtained from the treatments 25% whey bread and from bread without whey both rated 3 as neither like nor dislike. The overall acceptability of bread was also increased from 3 to 5 when water was fully replaced by whey. In general, the sensory evaluation result indicated that whey improved all the sensory attributes of bread. A study by Jooyandeh (2009) and Bilgin et al. (2006) reported that whey protein significantly increased the taste and overall acceptability of bread.

The result of sensory attributes based on flavour, sourness, taste, color and overall acceptability of porridge with different proportion of whey and water is presented in Figure 2. The sensory evaluation result showed that porridge with 25% whey ranked first in all sensory attributes scoring more than 4.5 out of 5.0, followed by 50% whey porridge. As the proportion of whey increased more than 50%, the sensory attributes started declining to a score of 2.0 which is dislike in five point hedonic scale.

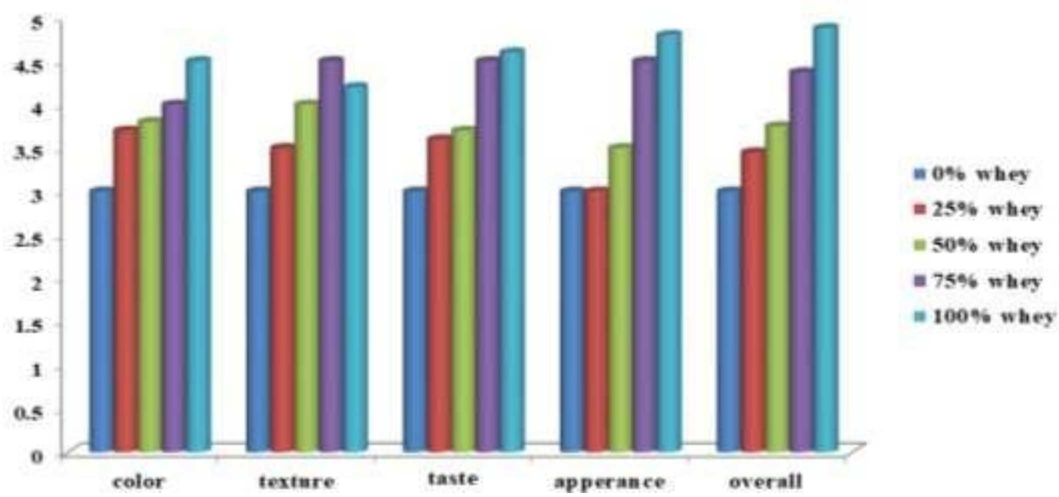

Figure 1. Sensory result of whey based bread in a five point hedonic scale

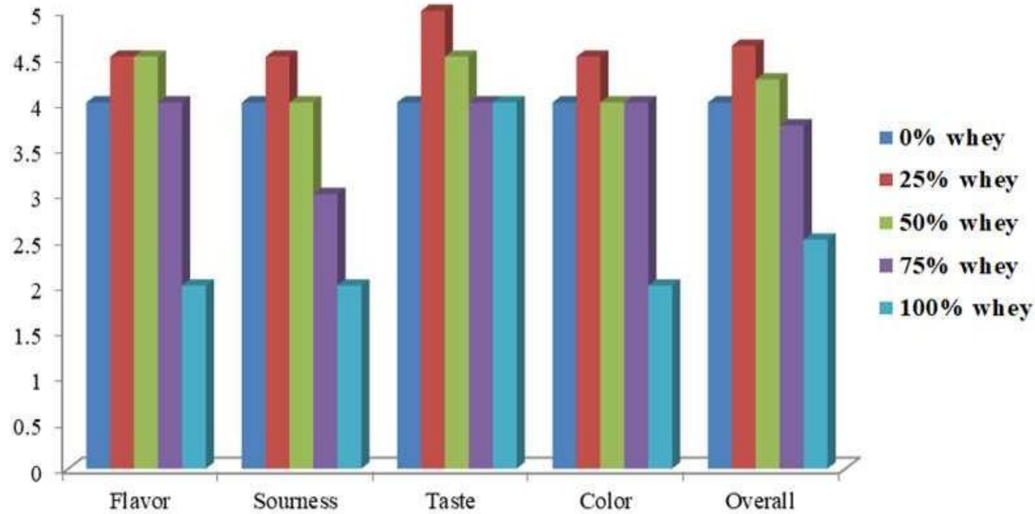

Figure 2. Sensory result of whey based porridge in a five point hedonic scale

The chemical composition of whey breads were presented in Table 1. In general a progressive increase in protein, fat and ash content of the bread was measured with increased levels of whey. The protein, fat and ash content of the bread were highest at the 100% whey blended bread. While, the 75% and 100% whey treatments significantly increased protein and fat contents of the bread compared to bread with less proportions of whey. This indicates that blending of whey during bread preparation might have enhanced the nutritive value of the bread. The present result is in agreement with Rantamaki et al (2006) that reported whey is a suitable dairy by-product with appreciable ingredients to enhance the nutritive value of foods such as bread. The improvement of ash contents with whey level is also similar to the finding of Salazari et al (2017) who indicated whey has substantial amount of minerals. The pH of the bread increased significantly from 5.81 to 5.93 which is an increment of 0.12 units.

Table 1. Chemical composition of whey bread

Treatments	% protein	% fat	% ash	pH
Water (T1)	9.85 ± 0.96[c]	0.27 ± 0.13[b]	1.34 ± 0.29[c]	5.81± 0.03[d]
75 water /25 whey (T2)	10.64 ± 0.60[bc]	0.38 ± 0.08[b]	1.47 ± 0.24[bc]	5.85 ± 0.03[c]
50 water /50 whey (T3)	11.18 ± 0.11[ab]	0.36 ± 0.09[b]	1.92 ± 0.24[ab]	5.86 ± 0.05[c]
25 water /75 wehey (T4)	12.12 ± 1.08[ab]	0.46 ± 0.08[ab]	2.14 ± 0.36[a]	5.88 ± 0.07[b]
Whey (T5)	12.37 ± 1.18[a]	0.65 ± 0.12[a]	2.22 ± 0.29[a]	5.93 ± 0.09[a]

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

The result of the chemical composition of whey porridge depicted in Table 2.The result indicates that the average protein content was significantly influenced by the ratio of whey. The highest porridge protein values of 10.91 and 10.77% were recorded for 75% and 100% whey blended porridge respectively, and the lowest porridge protein value of 8.91% was obtained for the porridge without whey. There was significant difference ($p<0.05$) in fat contents and the 100% whey porridge estimated as highest fat content among all treatments. Blending of porridge with whey also increased ash content of the porridge. These findings are in agreement with that of Mathewos and Shimelis (2014).

Table 2. Chemical composition of whey porridge

Treatments	Protein (%)	Fat (%)	Ash (%)	pH
Water (T1)	8.91 ± 0.25^{b}	0.62 ± 0.02^{b}	1.86 ± 0.67^{b}	4.53 ± 0.04^{d}
75% water/25 %whey (T2)	9.74 ± 0.71^{ab}	0.65 ± 0.01^{b}	2.21 ± 0.57^{b}	4.55 ± 0.05^{c}
50 water/50 whey (T3)	9.87 ± 0.52^{ab}	0.77 ± 0.12^{ab}	2.82 ± 0.39^{ab}	4.58 ± 0.06^{c}
25 water/75 whey (T4)	10.91 ± 0.86^{a}	0.78 ± 0.11^{ab}	2.82 ± 0.28^{ab}	4.73 ± 0.07^{b}
Whey (T5)	10.77 ± 0.82^{a}	0.89 ± 0.10^{a}	3.47 ± 0.79^{a}	4.95 ± 0.09^{a}

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

Fortifying bread and porridge with whey significantly enhanced their sensory acceptability and nutritive values. The protein, fat and ash contents of both bread and porridge increased with increasing proportion of whey in the blends. In sensory evaluation, acceptability of bread increased with increasing proportions of whey, whereas porridge with 25% whey had the highest acceptability. Hence, based on the nutritive value and sensory acceptability, 100% whey blended bread and 25% whey blended porridge could be recommended for further promotion at community level to address the existing problem of protein energy malnutrition.

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