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Nutritional Comparison of Cow and Buffalo Milk Cheddar Cheese

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Abstract: Cheddar cheese was manufactured from cow and buffalo milk using commercially available starter cultures (*Lactococcus lactis* ssp. *Cremoris* and *Lactococcus lactis* ssp. *Lactis*). Cheese was analyzed for proximate composition, pH, acidity, lactose and mineral contents and sensory perception (flavor, aroma and texture) after 2 and 4 months of ripening. All the chemical composition was significantly influenced by cow and buffalo milk. Buffalo milk cheese was found considerably superior in nutritional profile. Lactose content and pH decreased and acidity increased significantly during ripening of 120 days. On sensory evaluation, buffalo milk cheese was ranked appreciably higher for all the sensory parameters as compared to that of cow milk.

Key words: Buffalo milk, cow milk, cheddar cheese, chemical composition and sensory evaluation

Introduction

Cheese is a form of milk preservation and is highly nutritious, convenient and versatile and offers a diversity of flavors, textures and forms (Fox *et al*., 2000; Singh *et al*., 2003; Farkye, 2004). The diversity is due to an increasing knowledge of the technology of cheese making and the biochemistry and microbiology of cheese ripening (Farkye, 2004).

Cheddar is a hard ripened cheese produced by acidification and concentration of milk following gel formation with rennet (Banks, 2002). It forms a significant proportion of international trade in cheese and as a result of new world trade agreements, the volume of cheese traded is likely to increase (Muir *et al*., 1997).

The Cheddar cheese is a complex mixture, consisting of protein, fat, carbohydrates, vitamins and minerals. The component balance theory states that a mixture of the right chemicals at the appropriate levels would produce a Cheddar aroma and texture. However, when these components are out of balance, it is impossible to predict the sensory responses (House and Acree, 2002). Moreover, it has high nutritional value due to its high concentration of casein which contains various levels of all essential amino acids (Hughes and Willenberg, 1993). It also contains fat and small amount of other nutrients such as vitamin A, B_2, B_6 and B_{12}. Because of its high protein and calcium contents, cheese in moderation is an important component of balanced diet (Considine, 1982).

Quality of Cheddar cheese depends on manufacturing technology, starter cultures and composition of milk (Banks, 2002). A mixture of moisture, fat, salt, peptides, amino acids, micro flora, minerals and other minor constituents, occluded within a casein matrix combine to make Cheddar cheese a complex food (Maarse *et al*., 1994).

Buffalo's milk is ranked second in the world after cow's milk, being more than 12% of the world's milk production (CNIEL, 2002). In India and Pakistan (both producing about 80% of the world's production of buffalo milk), this milk is used for making different dairy products including soft and hard cheeses (Ahmad *et al*., 2008).

As compared to cow milk, buffalo milk is richer in fat, lactose, protein, total solids, vitamins and minerals, such as calcium, magnesium and inorganic phosphate (Fundora *et al*., 2001; Ahmad *et al*., 2008).

In most of the world, Cheddar cheese is manufactured from cow milk but keeping in view the production of buffalo milk in Pakistan and its composition, the present study was conducted to manufacture cow and buffalo milk Cheddar cheeses and their nutritional comparison.

Materials and Methods

Milk procurement: The buffalo and cow milk was procured from farm house, Institute of Animal Nutrition and Feed Technology, University of Agriculture, Faisalabad, Pakistan.

Cheese manufacturing and ripening: Commercially available freeze dried cultures of Cheddar cheese (*Lactococcus lactis* ssp. *Cremoris* and *Lactococcus lactis* ssp. *Lactis*) were used to manufacture cheese from cow and buffalo milk. Both of the milk was standardized at 3.5% fat level and cheese was prepared following the standard protocol, with some modifications, as described by Scott (1981). Ripening was done at 4°C for a period of 4 months.

Quality evaluation of cheese

Chemical analysis: Proximate composition, pH, acidity, lactose and mineral contents were determined in fresh cheese and after 2 and 4 months during ripening.

Table 1: Effect of ripening on chemical composition of cow and buffalo milk Cheddar cheeses

Chemical analysis	Cow milk Cheese				Buffalo milk cheese			
	0 day	60 days	120 days	Means	0 day	60 days	120 days	Means
Moisture	37.60	36.58	36.12	36.77[a]	36.38	35.83	35.10	35.77[b]
Fat	30.58	30.23	29.83	30.21[b]	32.62	32.31	32.06	32.33[a]
Protein	25.51	25.20	24.92	25.21[b]	26.60	26.40	26.12	26.37[a]
Ash	3.85	3.84	3.85	3.85[b]	4.01	4.08	4.11	4.07[a]
Lactose	0.13[a]	0.09[b]	0.04[c]	0.09[b]	0.16[a]	0.12[b]	0.08[c]	0.12[a]
Acidity	0.89[b]	0.93[ab]	0.96[a]	0.93	0.90[b]	0.93[ab]	0.96[a]	0.93
pH	5.34[a]	5.25[b]	5.18[c]	5.26	5.33[a]	5.25b	5.19[c]	5.26

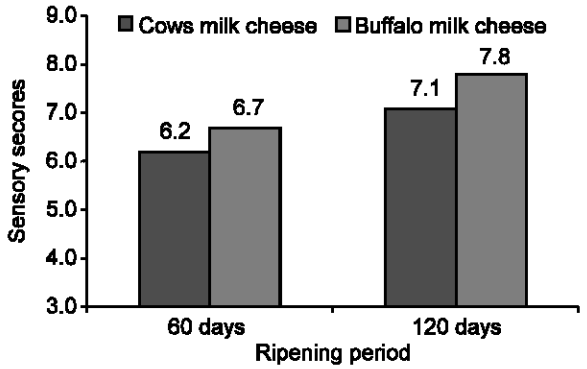

Fig. 1: Effect of ripening on flavor (scores) of Cheddar cheese

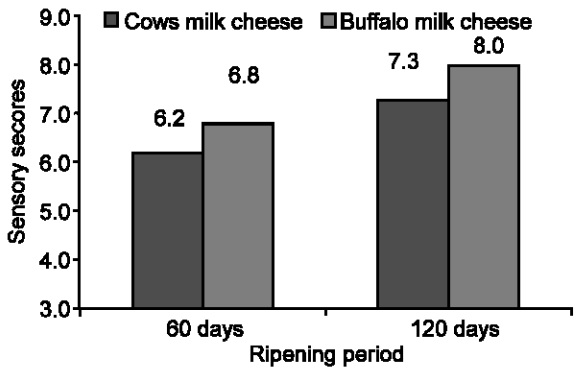

Fig. 2: Effect of ripening on aroma (scores) of Cheddar cheese.

Moisture content was determined by oven drying, fat content using Babcock method, total protein by Kjeldahl method, ash content by igniting the cheese sample, acidity by titrimetric method (AOAC, 1990) and lactose contents as described by Lees (1971). The pH of cheese slurry prepared by blending 20 g of grated and shredded cheese sample with 12 ml of water, was measured with a pH meter (inoLab WTW Series 720) after calibrating with fresh pH 4.0 and 7.0 standard buffers (Onga *et al.*, 2007). Sodium, calcium and potassium contents were determined using flame photometer as described by Kirk and Sawyer (1991).

Sensory evaluation of cheese: Cheese was evaluated for sensory characteristics after 60 and 120 days of ripening by a panel of assessors on 9-point hedonic scale (Land and Shepher, 1988).

Results and Discussion

Chemical composition: Significant differences in chemical composition of cow and buffalo milk Cheddar cheese were found. Moisture content of cow milk cheese (36.77%) was significantly ($p<0.05$) higher than buffalo milk cheese (35.77%). Fat, protein, ash and lactose content (32.33%, 26.37%, 4.07% and 0.12% respectively) were significantly ($p<0.05$) higher in buffalo milk cheese than that of cow milk (30.21%, 25.21%, 3.85% and 0.09% respectively). Non-significant ($p>0.05$) effect of milk was found on acidity and pH values of the cheese (Table 1).

The significant differences in cheese composition were because of the reason that as compared to cow milk, buffalo milk is richer in fat, lactose and protein, especially casein (Ahmad *et al.*, 2008) which is the major constituent that influences the cheese yield and composition. Fundora *et al.* (2001) also reported that the buffalo milk has a higher content of fat, crude protein, lactose, total solids, vitamins and minerals as compared to cow milk.

The Cheddar cheese composition obtained in present study is in accordance with the findings of Hughes and Willenberg (1993) who proposed the average chemical composition of Cheddar cheese as moisture 37%, protein 25%, fat 33% and ash 4%.

During ripening, lactose content significantly ($p<0.05$) decreased resulting in significant increase in acidity and decrease in pH value of buffalo as well as cow milk cheese while ripening had non-significant ($p>0.05$) effect on all other compositional parameters (Table 1).

The significant effects are due to the cheese being a biochemically dynamic product that undergoes significant changes during ripening (McSweeney and Sousa, 2000) and these changes are as a result of several microbiological, biochemical and metabolic processes. (Singh *et al.*, 2003; Farkye, 2004). The most significant one is the metabolism of lactose to lactate and other metabolites by lactic acid bacteria that influence the rate and extent of acidification (McSweeney and Fox, 2004). Onga *et al.* (2007) also reported that

Table 2: Effect of ripening on mineral contents of cow and buffalo milk Cheddar cheeses

	Cow milk Cheese				Buffalo milk cheese			
Minerals	0 day	60 days	120 days	Means	0 day	60 days	120 days	Means
Sodium	662.00	668.50	671.67	667.39[b]	680.33	682.25	685.92	682.83[a]
Calcium	721.08	723.58	726.83	723.83[b]	751.25	753.58	759.75	754.86[a]
Potassium	78.50	83.33	86.92	82.92[b]	82.83	87.33	89.83	86.66[a]

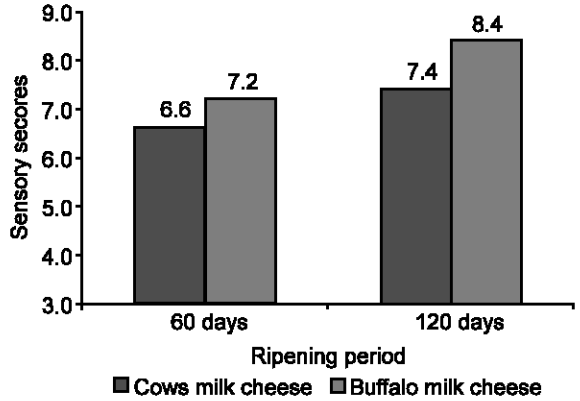

Fig. 3: Effect of ripening on texture (scores) of Cheddar cheese.

during ripening, the residual lactose predominantly metabolized to L-lactate. Moreover, the capacity of milk to be acidified is higher for buffalo milk than for cow milk (Ahmad *et al.*, 2008).

Mineral contents: During ripening, non-significant ($p>0.05$) changes were recorded in mineral contents of buffalo as well as cow milk cheese. However, all the three minerals; sodium, calcium and potassium were found highly significant ($p<0.01$) in buffalo milk cheese as compared to that prepared from cow milk (Table 2). It is for the reason that as compared to cow milk, buffalo milk is higher in mineral content especially calcium (Fundora *et al.*, 2001; Ahmad *et al.*, 2008). On acidification, similar solubilization of calcium and other minerals was observed by Ahmad *et al.* (2008) in both cow and buffalo milk that validate the non-significant changes in mineral content during ripening of cheese.

Sensory evaluation: Significantly higher ($p<0.05$) scores were awarded to the cheese prepared from buffalo milk as compared to that of cow milk for all the sensory parameters (flavor, aroma and texture) as illustrated in Fig. 1, 2 and 3. Fundora *et al.* (2001) described that compared with cow milk; the composition of buffalo milk imparts a rich flavour and taste and makes it a highly suitable ingredient for the manufacture of a wide variety of milk products particularly cheese.

Moreover, ripening had highly significant ($p<0.01$) effect on sensory perception of cheese as the scores for flavor, aroma and texture of cheese obtained after 120 days of ripening are much higher than that awarded after 60 days (Fig. 1, 2 and 3) because during cheese ripening, the biochemical and metabolic processes are responsible for the basic flavour and textural changes (Collins *et al.*, 2003; Lucey and Singh, 2003; Smit *et al.*, 2005). Singh *et al.* (2003) illustrated that the characteristic flavour, aroma, texture and appearance of cheese develop during ripening and these changes are predetermined by the composition of milk and starter culture.

Conclusion: It was concluded that the nutritional value and acceptability of Cheddar cheese manufactured from buffalo milk is much superior to that of cow milk. So, the buffalo milk because of its chemical composition, offers excellent opportunities for the development of different dairy products.

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