NUTRITIONAL EVALUATION OF DIFFERENT CHEDDAR CHEESE VARIETIES MADE FROM BUFFALO AND COW MILK

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ABSTRACT: The effect of milk source on physico-chemical properties of cheddar cheese was studied. Cheddar cheese samples were prepared from milk of buffalo, cow and their combinations in 75:25, 50:50 and 25:75 ratios. These samples were analyzed for moisture, ash, fat, protein, lactose, total solids, solid non-fat, energy contents, pH, titrable acidity and sensory characteristics. The results showed higher moisture content 42.96% in cow milk cheese than 41.65% in buffalo milk cheese and 41.20% in cheese made from 50:50 combination of milk. However, it was comparable to 25:75 and 75:25 combinations. The ash 3.936-4.000% and protein contents 23.39-23.55% were more or less the same for all cheese samples, except 25.44% protein content of 50:50 combination of milk. The buffalo milk cheese had the highest fat content of 30.18%. The pH decreased from 6.05 to 5.62 and titratable acidity increased from 0.018 to 0.056% for all cheese samples during three-days. Analysis of all cheese samples, particularly those with higher content of buffalo milk showed good sensory characteristics. Thus, buffalo milk and different combinations of buffalo and cow milk could be preferred over cow milk alone for making good quality cheddar cheese.

Keywords: Cheddar cheese, buffalo milk, cow milk, physico-chemical properties, sensory characteristics.

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INTRODUCTION

Cheese is a generic name of fermented milk, prepared as a result of coagulation of milk due to the presence of lactic acid which is produced by added micro-organisms (Egbenni *et al*., 2010). Approximately, one-third of the milk is used for cheese production throughout the world. Cheese production is basically a dehydration process in which the fats, proteins and minerals are concentrated 6-12 times depending on the type of cheese. During the conversion of milk into cheese, fat and casein protein of the milk is retained in the curd formed while other components such as whey protein is drained out (Farkye, 2004; Todar 2005). Although cow milk is usually used for cheese production, milk of other mammals like buffaloes, goats, yaks, ewes, camels, mares, donkeys, reindeer and zebra is also used. The type of milk affects the flavor of the cheese (Nash, 1969).

Out of more than 1400 types of cheese in the world, cheddar cheese is the most popular type of cheese after mozzarella cheese and its consumption as snacks and in fast food items has been increasing. Cheddar cheese is originally made from cow milk having *Lactococcus lactis* subspecies *lactis* and *Lactococcus lactis* subspecies *cremoris* that are mesophilic in nature, as starter culture (Chandan and Kilar, 2011). Cheddar cheese is highly nutritious having 25% protein, 20 to 60% fat, 4% mineral content, 34 to 42% moisture and less than 1% lactose (Harbutt, 1999). However, cheddar cheese made from buffalo milk has been found to be nutritionally superior having significantly greater content of protein, fat ash, lactose, sodium, calcium, potassium and organic acids such as lactic acid, citric acid, butyric acid compared to cheese made from cow milk. Also sensory analysis of cheddar cheese made from buffalo milk showed that it has better sensory characteristics as compared to cow milk cheese (Murtaza *et al*., 2008 and Sameen *et al*., 2008).

In Pakistan, buffalo milk production and consumption is much more than cow milk and sometimes large amount of milk is wasted due to its short shelf life and improper storage. Preparation of cheddar cheese from buffalo milk or its combination with cow milk will not only help in consuming and preserving the milk but might also produce a more nutritious cheddar cheese. The purpose of this research was to develop cheddar cheese from buffalo milk, cow milk and their combinations leading to sensory analysis of cheese samples for comparison for dairy sector.

MATERIALS AND METHODS

Sampling: Fresh raw milk of buffalo and cow was purchased from a local market of Lahore and was stored at 4°C in stoppered bottles.

Physico-chemical Analysis of Milk: The raw milk samples were analyzed for various physico-chemical characteristics such as pH, titratable acidity, specific gravity, moisture, ash, fat, protein, solid non-fat (SNF) content, total solids and energy by using (AOAC, 2005) protocols. Specific gravity and SNF content of milk were determined using a calibrated lactometer. Moisture contents were determined by oven-dry method while Gerber method was used for the determination of fat contents. Kjeldahl method was used for protein contents estimation (AOAC, 2005). The lactose contents of the milk sample were determined by Picric acid method (Awan and Rehman, 1997). The remark about solids or solid non-fat is not completely legible on the scanned page no 6?

Preparation of Cheddar Cheese Samples: Five cheese samples were prepared from buffalo, cow and combinations of buffalo and cow milk in the ratio 25:75, 50:50 and 75:25, respectively. Each cheese sample was produced from 1kg milk using the Milled-curd method of cheddar cheese production described by (Rehman *et al*., 2008).

Starter culture for preparation of cheddar cheese was provided by Adam's Cheese. 2% of this culture was added to pasteurized milk. After 10 min, 0.1ml of 35% calcium chloride solution was added. Milk was then placed in an oven at 30°C for an hour. After that the rennet was added in the milk in the ratio of 1:10 and milk was again placed in an oven for 40-50 min, allowing the formation of curd. The curd was stirred gently for 20 min and the curd-whey was slowly heated to a temperature of 38-40°C for 45 min while stirring. Stirring was continued for 30-50 min until the pH was 6.2. The whey was then drained out and the curd was allowed to fuse. Then 2-2.5% sodium chloride (table salt) was added in the cheese and mixed. Cheese was filled into a mould, pressed for a couple of hours and stored in the refrigerator.

Physico-chemical and Sensory Analysis of Cheese Samples: The pH and titratable acidity of prepared cheese samples were determined for first three consecutive days according to (AOAC, 2005). Moisture, ash, fat, protein, lactose, total solids, solid non-fat (SNF) contents and total energy were also determined according to AOAC protocols for cheese. The fat contents of cheese were determined by the chloroform and methanol extraction method. Cheese samples were analyzed by ten observers for sensory characteristics such as appearance, aroma, flavor and texture on a hedonic scale of 1-5 (1= very poor, 2=poor, 3=average, 4=good and 5= very good) and an average value for each attribute was determined.

RESULTS AND DISCUSSION

Physical characteristics of buffalo and cow milk were determined. The pH of buffalo milk was (6.85) which was slightly higher than that of cow milk (6.75). The titrable acidity and specific gravity of cow milk were 0.175% and 1.030 which were higher than buffalo milk i.e. 0.145% and 1.027. Chemical composition analysis was also performed as shown in Figure 1. Buffalo milk contained higher amounts of protein 3.240%, fat 7.350%, ash 0.790%, solid non-fat 9.212%, total solids 15.2% and energy 94.59 kcal/100ml as compared to cow milk which had 3.230% protein, 4.40% fat, 0.720% ash, 8.938% solid non-fat, 13.54% and total solids, 68.21 kcal/100ml of energy. The moisture and lactose contents in cow milk were 86.47% and 3.920% as compared to buffalo milk i.e. 84.18% and 3.870% respectively. The changes in pH and titrable acidity during first three days of each cheese sample are presented in Table 1. A decrease in pH and increase in titrable acidity during first three consecutive days after preparation was observed.

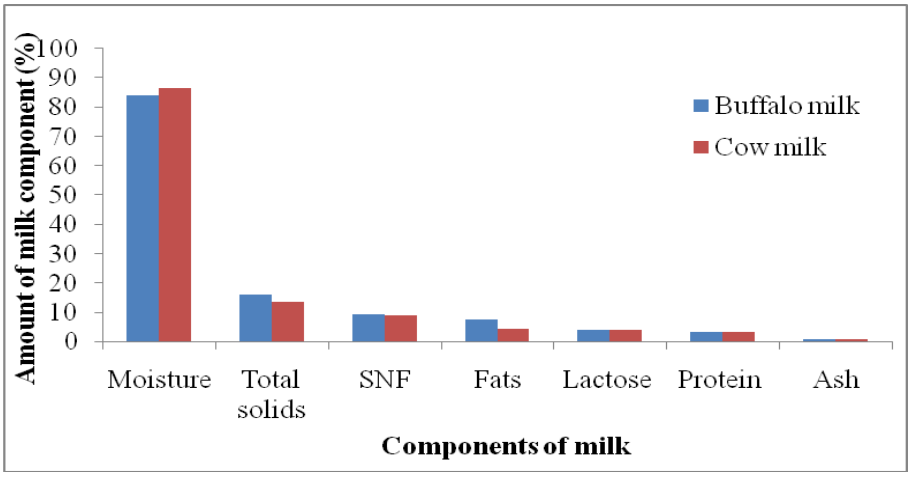

Figure 1. Chemical composition of milk samples.

Slight difference of values among all cheese samples was noticed with highest titrable acidity value of 0.056% for buffalo and cow milk combination in the ratio 25:75 on third day. The chemical composition of cheese samples presented in Table 2 showed that cheese made from buffalo and cow milk in the ratio 50:50 had higher amounts of protein 25.44%, ash 4.000%, lactose 0.990%, total solids 58.81% and solid non-fat contents were 30.44% whereas, fat contents and energy were highest in buffalo milk cheese i.e. 30.18% and 368.6 kcal/100g, respectively. Moisture contents were also highest 43.32% in cheese made from buffalo and cow milk in the ratio 25:75.

Table 1. Changes in pH and titrable acidity of cheese samples during first three days after preparation.

Source of milk	pH at 20°C			Titrable acidity (%)		
	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Buffalo	5.94	5.89	5.78	0.038	0.045	0.049
Cow	6.02	5.83	5.62	0.025	0.031	0.041
Buffalo + Cow (25:75)	5.88	5.82	5.74	0.031	0.040	0.056
Buffalo + Cow (50:50)	6.05	5.97	5.84	0.018	0.027	0.036
Buffalo + Cow (75:25)	5.93	5.73	5.64	0.023	0.036	0.047

Table 2. Chemical analyses of cheese samples prepared from milk of buffalo, cow and their combinations.

Components (%)	Buffalo	Cow	Buffalo + Cow (25:75)	Buffalo + Cow (50:50)	Buffalo + Cow (75:25)
Moisture	41.65	42.96	43.32	41.20	42.95
Protein	23.55	23.39	23.43	25.44	23.46
Fat	30.18	28.94	28.54	28.37	28.87
Ash	3.936	3.993	3.967	4.000	3.981
Lactose	0.684	0.717	0.753	0.990	0.739
Total solids	58.35	49.87	56.68	58.81	57.05
Solid non-fat (SNF)	28.17	20.94	28.14	30.44	28.18
Energy (kcal/100g)	368.6	356.9	353.6	361.1	356.6

The results of milk analysis showed that buffalo and cow milk had different physical and chemical characteristics. The results pertaining to physical characteristics of buffalo and cow milk were similar to findings of previous researchers (Khanwal *et al*., 2004 and Ahmad *et al*., 2008). Percentage content of fat, ash, moisture and total solids of both buffalo and cow milk was similar, while protein and lactose contents were less than what has already been reported by (Soliman, 2005). Variations in the chemical composition of buffalo and cow milk were due to the difference in species, breed, diet, lactation period and the age of the animal. Physical characteristics of buffalo and cow milk differed due to variations in their chemical composition.

Decrease in pH and increase in titrable acidity indicated that the culture was active, fulfilling its function of developing the flavor of cheddar cheese during the ripening period. These changes occurred initially because of lactic acid being produced by the starter culture and later as a result of loss of activity of the culture and the rennet used as coagulant. These changes in pH and titrable acidity have been reported for raw cow milk cheese by (Harbutt, 1999). The slight difference in moisture, protein, ash and fat contents of cheese samples were due to difference in the composition of milk used for cheese preparation. All cheese samples contained a very low amount of lactose because, the culture present converted the lactose into lactic acid during fermentation and some of it was lost along with whey proteins. According to another study, buffalo milk cheese was nutritionally superior as it has significantly higher protein, fat, ash, lactose, minerals and lactic acid contents as compared to that prepared from cow milk (Murtaza *et al*., 2014).

The results of sensory analysis of cheese samples are shown in Figure 2. Buffalo milk cheese scored 4.5, 3.7, 3.8 and 3.5 in appearance, texture, aroma and flavor, whereas, cow milk cheese scored 4.7, 3.7, 3.5 and 3.2, respectively. The cheese made from 25:75 combination of buffalo and cow milk scored 4.3 in appearance, 3.8 in texture, 3.4 in aroma and 4.0 in flavor. Cheese made from 50:50 combination scored 4.4, 4.0, 4.3 and 3.6. Cheese prepared from buffalo and cow milk in 75:25 ratio scored 4.0, 4.2, 3.8 and 4.2 in the given sensory characteristics. Cheese made from buffalo and cow milk in the ratio of 75:25 had the best score of 4.2 both for flavor and texture. Whereas, cheese made from buffalo and cow milk in the ratio of 50:50 had best score of 4.3 for aroma. The cow milk cheese had best appearance having a score of 4.7.

The sensory characteristics observed from all cheese samples were good. Buffalo milk cheese was white, while cow milk cheese was yellowish in color. This difference in color was due to variation in natural pigments such as biliverdin or carotenoids present in buffalo or cow milk. Cheddar cheese prepared from buffalo milk showed better sensory characteristics than that prepared from cow milk. Mixing of buffalo and cow milk in any of the three ratios studied produced better characteristics in cheese than those found in cheese made from cow milk only. The variations in sensory characteristics of the prepared cheese samples occurred due to differences, not only in the fat contents but also the type of fat present. The fat present contributed to flavor directly as well as indirectly through lipolysis and metabolism of the fatty acids formed.

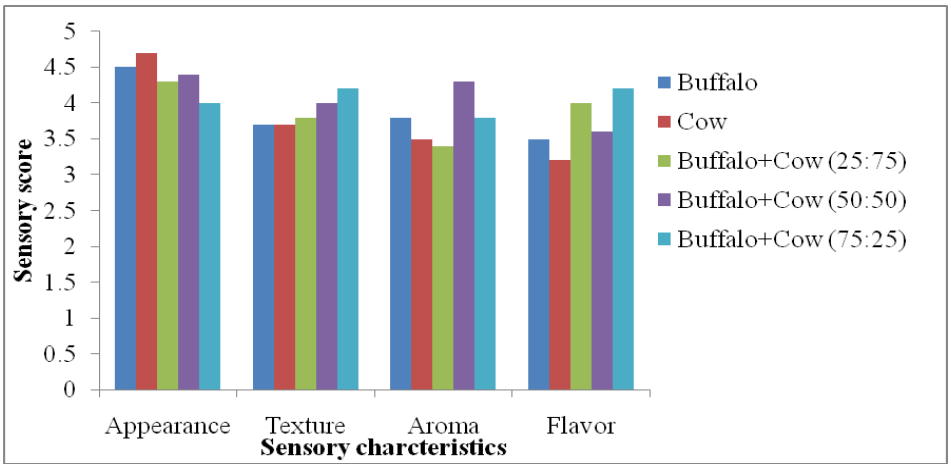

Figure 2. Sensory evaluation of cheese samples prepared from milk of buffalo, cow and their combinations.

Conclusion: High nutritional value and good sensory characteristics such as, aroma, flavor, texture, and appearance were achieved for cheddar cheese made from buffalo milk or any of the three combinations of buffalo and cow milk. Therefore, buffalo milk and combinations of buffalo and cow milk could be a better choice for production of good quality cheddar cheese rather than using cow milk alone.

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