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Effect of Buttermilk on the Physico-Chemical Attributes of Muffins

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A B S T R A C T

Buttermilk is a byproduct of butter obtained from churning of sweet and sour cream into butter. From many years, buttermilk has been underestimated due the byproduct of dairy industry. But now, it is consider as an important product because it has strong flavour, emulsifying properties, presence of large amount of Milk Fat Globule Membrane (MFGM) of milk and also rich in membrane components like phospholipids, sphingolipids, glycoproteins, specific proteins and some other minor components. The present study was done to prepare the buttermilk containing muffins by complete or partially substituted of water with buttermilk by adding different percentages (0, 50 and 100%) of buttermilk (Sweet and Sour). The buttermilk containing Muffins then analyzed for the physico-chemical properties for 7 days storage study and analysis done at 0, 3, 5 and 7 days and mineral profile and sensory evaluation at 0 day. The mean value for proximate analysis moisture ranged (17.68-32.52%) which describes the decreasing trend, ash (0.71-0.98%), crude protein (6.85-9.94%), crude fat (20.24-26.93%), crude fiber (0.51-0.74%) and NFE (29.70-53%) increased with passage of time. Minerals profile values include Ca, K and Na which are 155.67-173 mg/100 g, 577.23-594.97 mg g^{-1} and 143.50- 147.27 mg g^{-1}, respectively. After texture analysis of muffins it was observed that the hardness of muffin decreased by increasing the percentage of buttermilk which is 43.66-65.60. Furthermore, in the sensory properties of buttermilk containing Muffins M_2 (contained 100% sour buttermilk) were preferred by the sensory panel due to the attractive characteristic like color, flavor, texture, tenderness, moistness, shape and over all acceptability. Hence, buttermilk can increase the flavor softness, color, texture of the muffins.

Key words: Muffins, buttermilk, sweet and sour cream, dairy, fermented products

INTRODUCTION

Food is an essential part of human's life. Out of many foods component milk is an important factor that must be added in diet. Milk and its dairy products are important for the human health because they contained higher content of vitamins, protein and minerals particularly potassium, calcium, phosphorous and magnesium. These dairy products can be made more nourishing by addition of various balancing ingredients like multivitamins, minerals, fruit pulp, chocolate, ginger and clove. These dairy products may increase satisfactoriness and quality by doing these practices.

Cultured milk products are receiving more popularity than other products of dairy because new ranges of various items of food manufactured from these milk products frequently origination in commercial market. The base of

fermented dairy products in the diet of humans is back around thousands of years. About 10,000-15,000 years ago in different religions of the world prepared cultured milk products. Fermented products of milk have acidic pH due to live microbial strains called probiotics. These beneficially affects the hosts by improving intestinal balance, so they give excellent healthful and nutritional characteristics to society. In GIT, these healthful microbes present live and helps to save us from many diseases (Lankaputhra *et al*., 1996; Shah, 2007). Because of the helpful effects of probiotics the fermented milk products are called "Probiotics foods" (De-Oliveira *et al*., 2001). Differently used probiotics products contain numerous types of yoghurt, a many kinds of drinks that cover ropy milk, lactic acid bacteria ('Takult-type'), acidophilus milk, cheese and cultured buttermilks.

Dairy by products are as essential as the chief products of these (dairy) industries. One of these by-products there is buttermilk. Butter milking includes stirring and churning in the presence of air which causes aggregation or coagulation of fat particles and disruption of their protein or phospholipids containing membranes. The material present in these membranes in liquid form and other water soluble material together called buttermilk (Sachdeva and Buchheim, 1997).

Some years back buttermilk was considered as waste. In the 18th and 19th centuries buttermilk was considered as a un necessary food of diet in Ireland. Then from year 1980-2002 the buttermilk products sales decreased from 420.5-248.1 million kg. The quantity of buttermilk is very near to the butter's production so, if we prepared butter from cream that may be sour or sweet that contains fat (40%) then mostly 4.1 million tons buttermilk will be produced throughout the world. In the year 2006 overall production of buttermilk was about 8.6×10^6 t (FAOSTAT, 2006).

Buttermilk is liquid phase released during churning of cream into butter in butter making process either manufacture or use industrially or domestically (Morin *et al*., 2007). For many years the use of buttermilk has been underrated. Recent highlights on its high value composition have, however, changed the past opinions (Contarini and Povolo, 2013).

The consumption of buttermilk varies from climate to climate and from region to region. It is used as fresh milk drink in various regions especially in hot climates. The consumption of buttermilk among countries within warm climates such as Pakistan, India, Afghanistan, Sri Lanka and southern United States is high. However, the consumption of buttermilk within countries having cold climate such as European countries is generally quite low (Abeid *et al*., 2001).

The composition of buttermilk is same as that of skimmed milk except fat content. When compared to other dairy products, high amounts of MFGM are one of the characteristic components of buttermilk. The integrity of MFGM is responsible for protection and stability of milk fat in whole milk (Niederau *et al*., 1998; Schmelz *et al*., 2000). The churning of whole milk for production of buttermilk and butter destroys the complex integrity of MFGM which releases its various internal components such phospholipids and proteins (Morishita *et al*., 2002).

Due to similar composition and overall appearance of buttermilk to the skimmed milk but it holds high quantity of MFGM. Milk fat globule membrane is protein that represents only 1-4% of total or over all protein of milk. This MFGM surround a complex structure carbohydrates, proteins, neutral lipids, enzymes, triglycerides phospholipids and sphingolipids (Caroline *et al*., 2009). This fat globule membrane provides structural reliability, protection and stability of the milk fat in the liquid phase. It also has many properties related to health like anti-viral effect on rotaviruses strains. Phospholipids content of this membrane have potential physicochemical effects on health of brain helps inhibit the tumor growth and binding the cholesterol (Morin *et al*., 2007). Buttermilk gives almost 169 kJ or (40 kcal) energy, 0.2-0.9 g fat, 3.2-3.7 g protein, 4-5 g carbohydrates, 0.8 g ash and 90-91% moisture per 100 g (National Food Institute, 2009). It is a great source of different minerals like phosphorus, zinc, potassium, magnesium and calcium. It is also an excellent source of different types of vitamins like niacin, riboflavin, niacin, folic acid, niacin, vitamin B and vitamin B_{12}.

The improvement of skills and increase in knowledge has introduced the new and less costly methods of utilizing the buttermilk to formulate different products for the dairy industry. Some milk based fruit drinks are already available

in market. The present research was planned to use the buttermilk and fruit pulp in the formulation of drink which may reduce the use of synthetic and less nutritious carbonated beverages (Coca-Cola, Pepsi, 7-up, synthetic juices etc.).

Muffins are described as a quick bread "Quick-acting" chemical laving agents and "Longer-acting" biological agents are used. Muffins have become increasingly hot popular as bread served with meal or eaten as a snack (Baixauli *et al*., 2008).

Besides the consumption of fresh buttermilk as milk drinks and in dairy products, it has many applications in food industry and in feeding animals as a powder. Due to its high emulsifying properties buttermilk powder is used in cheese making. It has also been used in salad dressing and baked products because of high sensory properties and strong aroma and flavor (Abeid *et al*., 2001). Keeping in view it's emulsifying and flavor characteristics in dairy as well as baked products it will be used in preparation of muffins. The present study was done to prepare the buttermilk containing muffins by complete or partially substituted of water with buttermilk by adding different percentages (0, 50 and 100%) of buttermilk (Sweet and Sour).

MATERIALS AND METHODS

Procurement of raw materials: Fresh raw milk used in preparation of Sweet and sour buttermilk and in muffins different ingredient such as white flour, sugar, oil, baking powder, eggs and water was used; ingredients were purchased from local market of Faisalabad.

Methodology

Preparation of buttermilk (sweet and sour): The sweet and sour buttermilk was prepared from cream which was separated from raw milk. In sweet buttermilk cream kept for maturation about 3-4 h and then churned and in case of sour buttermilk the culture was apply and then churning of cream was done. Buttermilk was separated from butter at the end. Both of these buttermilk (sweet and sour) further used in preparation of muffins in different percentages. Formulation of muffins prepared by buttermilk.

Buttermilk was used for the preparation of muffins. White flour, suger, eggs and baking powder was sifted together for baking in a required amount. Buttermilk and water was added with different concentrations. There was a gradual replacement of water with buttermilk. The batter was then filled in muffins cups and was further placed in baking oven at a set temperature. Removed the muffin cups from baking oven and allowed to cool down and then presented for sensory evaluation and product proximate analysis. Treatment plan is shown in Table 1.

Analysis of muffins prepared by buttermilk

Proximate analysis: Proximate composition such as crude protein content, crude fiber content, moisture content, ash content, nitrogen free extract and crude fat content of muffins prepared by the buttermilk were examined and expressed on dry matter basis according to methods of AOAC (2000).

Moisture content: Moisture content of muffins was determined according to method No 44-15 given in AOAC (2000). The moisture percentage was calculated according to the following formula:

$$\text{Moisture}\,(\%) = \frac{\text{Wt. of original sample} - \text{Wt. of dried sample}}{\text{Wt. of original sample}}$$

Total ash: The sample was analyzed for ash content by following the method No. 08-10 given in AOAC (2000). Ash percentage was calculated by the following calculations:

Table 1: Treatment plan for muffins prepared by buttermilk

Ingredients	M_0 (%)	M_1(%)	M_2 (%)	M_3 (%)	M_4 (%)
Water	100			50	50
Buttermilk (Sweet)	-	100		50	-
Buttermilk (Sour)	-	-	100	-	50

$$\text{Ash (\%)} = \frac{\text{Ash weight}}{\text{Sample weight}} \times 100$$

Crude protein: Nitrogen contents were determined by Kjeldahl's method No. 46-10 AS given in AOAC (2000). Nitrogen percentage was determined by following expression:

$$\text{Nitrogen (\%)} = \frac{\text{Amount of 0.1 } NH_2SO_4 \text{ used} \times 0.0014 \times 250}{\text{Wt. of sample} \times \text{Vol. of aliquot}} \times 100$$

The crude protein percentage was determined by multiplying percent nitrogen with 6.25 factors:

$$\text{Protein (\%)} = \text{Nitrogen\%} \times 6.25$$

Crude fat: Crude sample was determined by placing moisture free sample in a soxhlet apparatus with application of petroleum ether as a solvent according to method No. 30-25 given in AOAC (2000). The following was used to calculate the crude fat percentage:

$$\text{Crude fat (\%)} = \frac{\text{wt. of ether extract}}{\text{wt. of sample}} \times 100$$

Crude fiber: Crude fiber determined according to the method No. 32-10 given in AOAC (2000). The loss in weight is the weight of crude fiber (W_2) in the sample. It is calculated by the following formula:

$$\text{Crude fiber (\%)} = \frac{W_1\text{-}W_2}{\text{Weight of sample}} \times 100$$

Nitrogen Free Extract (NFE): The NFE was calculated by subtracting the percentages of moisture, crude protein, crude fat, crude fiber and total ash from 100.

$$\text{NFE (\%)} = 100 - (\%\text{Moisture} + \%\text{Crude Protein} + \%\text{Crude Fat} + \%\text{ Crude fiber} + \%\text{ Total Ash})$$

Mineral analysis

Estimation of mineral contents (Ca, Na and K): For determination of different minerals, the filtered sample was loaded to the atomic absorption spectrophotometer. The mineral content of samples was analyzed by application of respective standard curve prepared for each element as mentioning method number 40-70 of AOAC (2000).

Physical analysis

extural analysis: Texture of muffins was analyzed according to Pap Antoniou (2003) by using a textural analyzer (Model. TA-XT2, Stable Microsystems, Surrey, UK) with a 5 kg load cell. Textural determinations were made by

using a 75 mm compression Platen (P/75) for a compression test. The greater the distance that this occurs, the greater is the ability to withstand compression without sample breakage.

Sensory evaluation analysis: Muffins prepared by the buttermilk were evaluated for sensory characteristics such as color, flavor, taste, texture, appearance and overall acceptability.

Statistical analysis: The results achieved from all parameters were subjected to statistical analysis following analysis of variance technique and results were interpreted by using difference in means which is calculated by least significance difference test (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Proximate analysis of muffins prepared by buttermilk

Moisture content: The statistical data on the moisture content of muffins presented in Table 2. Table 2 showed that treatments and storage significantly affected ($p<0.01$) the moisture content of muffins prepared with the addition of buttermilk (sweet and sour). Moreover, the interaction between treatments and storage days are also found significant ($p<0.01$) for the moisture content of muffins.

The mean values of moisture content of muffins prepared by adding buttermilk (sweet and sour) showed in Table 2 depicted that overall values regarding treatments for moisture content varies from 19-31.23% while moisture varies with respect to storage 23.21-25.27% for Muffins. The results exposed that the highest moisture content recorded in M_1 (32.52%) and lowest in M_0 (20.33%) at 0 day and at the 7 day M_1 contained (29.81%) and M_0 (17.86%). The muffins which is prepared with the 100% buttermilk (sweet and sour) contained high percentage of moisture than the controlled one which is M_1 (32.52%) and M_2 (31.23%), the Muffins prepared by 50% of buttermilk (sweet and sour) have less content of moisture but more than controlled one due the present of buttermilk which is M_3 (22.99%) and M_4 (20.88%) samples. After 3, 5 and 7 days there was notable decrease in moisture of muffins.

It is depicted from the above discussion that decrease in moisture content is directly related to temperature of environment. Due to the high temperature there was continuous decrease in moisture content of muffins. During storage change in moisture content in treatment is in agreement with findings of Estevaz *et al.* (1995). Above discussion also showed that the muffin contained 100% buttermilk have more moisture content it is due the high level of protein content present in the buttermilk that helps to retained moisture in muffins during baking. The results are similar to the Hassan *et al*. (2013) who showed more absorption of buttermilk in "Pan Bread Dough" than water.

Total ash: The analysis of variance on ash content of muffins prepared by the buttermilk (sweet and sour) and without buttermilk concerning storage and treatments showed in Table 3. As illustrated in the Table 3 storage days and treatments had highly significant effect ($p<0.01$) on ash content of the muffins. The interaction effect of the storage and treatments on ash content in muffins prepared by the addition of sweet and sour buttermilk was also observed highly significant ($p<0.01$).

Table 2: Effect of buttermilk on moisture content (%) of muffins during storage

	Storage				
Treatments	0	3	5	7	Mean
M_0	20.33^{m}	19.27^{o}	18.64^{p}	17.68^{q}	19.00 E
M_1	32.52^{a}	31.86^{b}	30.73^{c}	29.81^{d}	31.23A
M_2	29.97^{d}	29.46^{e}	28.89^{f}	28.11^{g}	29.11B
M_3	24.04^{h}	23.30^{i}	22.81^{j}	21.81^{k}	22.99C
M_4	21.51^{l}	20.38^{m}	19.81^{n}	18.64^{p}	20.08D
Mean	25.67A	24.85B	24.19C	23.21D	

Table 3: Effect of buttermilk on ash content (%) of muffins during storage

	Storage				
Treatments	0	3	5	7	Mean
M_0	0.72^{k}	0.71^{k}	0.73^{jk}	0.74^{j}	0.72E
M_1	0.94^{c}	0.96^{b}	0.97^{ab}	0.98^{a}	0.96A
M_2	0.90^{d}	0.93^{c}	0.92^{c}	0.93^{c}	0.92B
M_3	0.81^{i}	0.84^{h}	0.85^{gh}	0.86^{f}	0.84D
M_4	0.82^{i}	0.86^{fg}	0.86^{f}	0.88^{e}	0.85C
Mean	0.83D	0.86C	0.86B	0.88A	

Mean results on ash contents of Muffins prepared by the buttermilk (sweet and sour) are given in Table 3. From Table 3 it is depicted that the ash content regarding to treatments varies from 0.72-0.96% while related to storage days it varies between 0.83-0.88%. Maximum ash content of muffins was observed in M_1 0.94% and minimum value of ash content was recorded in M_0 0.72% at 0 day. At the 7th day of storage the highest value of ash content found in M_1 (0.98%) and lowest value observed in M_0 (0.74%). The muffins which is prepared with highest quantity of buttermilk (sweet and sour) M_1 and M_2 had more ash content than the muffins had less quantity of buttermilk M_3 and M_4 throughout the storage days. The mean values on ash of muffins showed increasing trend of ash content during storage days with minute changes.

The present study indicated that high ash content present in muffins prepared by the addition of buttermilk (sweet and sour) is due the higher mineral content in buttermilk which is reported by Hassan *et al*. (2013) during working on "Influence of substituting water with fermented skim milk, acid cheese whey or buttermilk on dough properties and baking quality of pan bread" and Wronkowska *et al*. (2014) while working on "ACID whey concentration by ultrafiltration a tool of modeling bread properties" which showed same results of ash contents regarding days and treatments.

Crude protein: The statistical results related to treatments and storage days on crude protein of muffins prepared by the buttermilk (sweet and sour) showed in Table 4. It is revealed from the Table 4 that treatments and storage showed highly significant effect ($p<0.01$) on protein content of muffins. Similarly, the interaction effect between storage days and treatments was also found highly significant ($p<0.01$).

The means concerning to protein contents of muffins prepared with and without buttermilk (sweet and sour) is given in Table 4. Table 4 showed that protein contents that obtained in Muffins in all treatments are varied from 7.05-9.83% and while with respect to storage days protein content ranges between 7.91-8.46%. Highest value for the protein contents of Muffins was observed in M_1 9.64 and 9.94% while lowest value was noticed in the M_0 6.85 and 7.44% at 1st and 7th day, respectively. Increasing trend was observed in mean values during storage. The muffins contained 100% of buttermilk M_1 and M_2 had higher content of protein than the muffins samples M_3 and M_4 had 50% of buttermilk. The M_3 and M_4 which contained 50% of buttermilk have more protein content than controlled.

It is clear from above results and discussion that the muffins containing 100% and 50% of buttermilk had higher crude protein content than controlled muffins that prepared from using water. The higher protein content in the muffins that have buttermilk is due to the protein present in buttermilk which also retained more moisture content in batter during baking and less evaporation of moisture than controlled samples. These values are similar with result reported by Abdel-Aal (2008) and also findings of Hassan *et al*., (2013) who reported more protein in buttermilk.

Crude fat: The statistical result on fat of muffins prepared by addition of buttermilk regarding treatments and storage are depicted in Table 5. From Table 5 it is clear that both treatments and storage had significant effect ($p<0.01$) on muffin samples. Similarly, the interaction effect of the treatments and storage was also found highly significant ($p<0.01$) in muffins with addition of sweet and sour buttermilk.

The data for mean values regarding fat contents of muffin prepared by buttermilk (sweet and sour) presented in Table 5. Depicted that overall means regarding treatments for fat content of muffins varies from 20.44-26.76% while

Table 4: Effect of buttermilk on protein content (%) of muffins during storage

	Storage				
Treatments	0	3	5	7	Mean
M_0	6.85^{k}	6.96^{k}	6.95^{k}	7.44^{hi}	7.05E
M_1	9.64^{b}	9.80^{ab}	9.95^{a}	9.94^{a}	9.83A
M_2	8.71^{de}	8.58^{e}	8.93^{cd}	8.96^{c}	8.79B
M_3	7.30^{hi}	7.30^{hi}	7.46^{h}	8.22^{f}	7.57C
M_4	7.03^{jk}	7.21^{ij}	7.30^{hi}	7.75^{g}	7.32D
Mean	7.91C	7.97C	8.12B	8.46A	

Table 5: Effect of buttermilk on fat content (%) of muffins during storage

	Storage				
Treatments	0	3	5	7	Mean
M_0	20.24^{n}	20.46^{m}	20.48^{m}	20.60^{l}	20.44E
M_1	26.51^{c}	26.69^{b}	26.90^{a}	26.93^{a}	26.76A
M_2	25.58^{f}	25.90^{e}	25.96^{d}	25.97^{d}	25.85B
M_3	23.59^{i}	23.70^{h}	23.82^{g}	23.82^{g}	23.73C
M_4	22.43^{k}	22.66^{j}	22.63^{j}	22.67^{j}	22.60D
Mean	23.67D	23.88C	23.96B	24.00A	

with respect to storage fat content varies between 23.67-24% in muffins. Highest value for fat content was recorded in M_1 (26.51%) and lowest value noticed in controlled M_0 (20.24%) at 0 day. With the storage, there was increasing trend noticed for fat content. The highest value in M_1 (26.93%) and least value were noticed in M_0 (20.60%) at 7 day of storage. The muffins samples M_3 and M_4 had high level of buttermilk have high level of fat content than the controlled M_0 which is made from water. There is increase in fat content of muffin were noticed during storage days.

The present study showed that the muffins made by buttermilk have higher content of fat due to the fat content present in the buttermilk (sweet and sour) during increase the level of buttermilk have similar findings to Hassan *et al*., (2013) during working on "Influence of substituting water with fermented skim milk, acid cheese whey or buttermilk on dough properties and baking quality of pan bread" in which results of fat contents is also significant regarding treatments as reported by Wronkowska *et al*., (2014) while working on "ACID whey concentration by ultrafiltration a tool of modeling bread properties".

Crude fiber: The statistical analysis on crude fiber content of muffins prepared by the buttermilk (sweet and sour) is given in Table 6. It is revealed from Table 6 that treatment and storage had highly significant effect ($p<0.01$) on the fiber contents of muffins. The interaction effect of storage days and treatments on muffins made by buttermilk (sweet and sour) addition was determined non-significant ($p>0.05$).

The overall means relating to fiber content of the muffins given in Table 6. It depicted that fiber content of muffins varies between 0.52-0.68% with respect to treatments while related to days it varies from 0.64-0.66% in muffins. Highest value for fiber content was recorded in M_2 (0.71%) at 0 day of storage while least value was recorded in M_0 (0.51%). At the 7 day of storage maximum value was found in M_2 (0.74%) and minimum value was noticed in M_0 (0.51%) showed that there is very small change observed in the fiber content in the muffins prepared by the buttermilk. It is illustrated from the Table 6 that there was very minor increase in the fiber content of muffins having 100% (M_1, M_2) and 50% (M_3, M_4) of buttermilk. Table 6 also showed almost similar trend with respect to interaction between days and treatments.

The above discussion showed that the fiber present in very minute quantity in the muffins prepared by buttermilk. The reason of less content of fiber present in muffins are white flour is used in batter and almost no fiber content is present in buttermilk. And also non-significant effect was noticed during storage days. These findings were similar to the results of different author and strongly favor their readings (Wronkowska *et al*., 2014; Hassan *et al*., 2013).

NFE: The analysis of variance on NFE of Muffins samples made by buttermilk addition (sweet and sour) illustrated in Table 7. Table 7 showed that statistical data related to different treatments and days were highly significant effect

Table 6: Effect of buttermilk on fiber content (%) of muffins during storage

	Storage				
Treatments	0	3	5	7	Mean
M_0	0.51	0.53	0.51	0.52	0.52D
M_1	0.67	0.67	0.68	0.69	0.68B
M_2	0.71	0.75	0.74	0.74	0.73A
M_3	0.67	0.67	0.67	0.68	0.67B
M_4	0.64	0.65	0.67	0.67	0.65C
Mean	0.64B	0.65A	0.65A	0.66A	

Table 7: Effect of buttermilk on NFE content (%) of muffins during storage

	Storage				
Treatments	0	3	5	7	Mean
M_0	51.32	52.06	52.59	53.00	52.24A
M_1	29.70	30.01	30.75	31.63	30.52E
M_2	34.10	34.37	34.53	35.27	34.56D
M_3	43.58	44.16	44.37	44.58	44.17C
M_4	47.56	48.22	48.70	49.36	48.46B
Mean	41.25D	41.76C	42.19B	42.77A	

($p<0.01$) on the NFE contents of the Muffins. Moreover, the results in the Table 7 exposed that the interaction effect between storage and treatments had non-significant ($p>0.05$) impact on NFE.

The means concerning to NFE contents of muffins samples prepared with buttermilk were given in Table 7 and it is illustrated from the Table 7 that values of NFE contents of buttermilk based muffins are 30.52-52.24% with respect to treatments while varies between 41.25-42.77% in case of storage period. From Table 7 it is clear that large changes were observed in NFE contents of muffins sample regarding to treatment. Maximum value was observed for NFE throughout the sample during storage in M_0 53% and minimum value observed was 29.70% in M_1. The muffins prepared by the addition of 100% buttermilk M_1 (30.52%), M_2 (34.56%) and 50% buttermilk M_3 (44.17%), M_4 (48.46%) had lowest content of NFE.

From the above discussion, it is depicted that the controlled muffins have highest value of NFE than the muffins prepared by the buttermilk. The reason is that the NFE content is depend upon the change in protein, fat, fiber, ash and moisture content of muffins made with and without addition of buttermilk. Buttermilk based muffins have high quantity of moisture, ash, protein and fat so they contained low value of NFE in muffins.

Mineral analysis

Calcium content of muffins: The statistical results for calcium content of different treatments of muffins prepared by addition of buttermilk in different proportion of buttermilk (sweet and sour) are presented in Table 8. It is illustrated from Table 8 that all results of treatments are highly significant ($p<0.01$) to each other.

The mean values for calcium content of muffin samples prepared with addition of buttermilk (sweet and sour) are mentioned in Table 8. The values of calcium are in increasing trend in different treatments due to the increased the concentration of buttermilk in its formulation. M_1 has the higher amount of calcium content 173 mg while M_0 shows least amount of calcium content 155.67 mg. There was an increasing trend with the increase the buttermilk level in samples of Muffins M_1 173 mg and M_2 170 mg in which 100% buttermilk is used.

The above discussion illustrated that the muffins contained buttermilk have more contents of minerals due to the minerals present in the buttermilk. The result was according to the findings of Spencer *et al*. (1991) who were reported increase in calcium content in Muffins.

Potassium content of muffins: The statistical results for potassium content of different samples of muffins made by buttermilk (sweet and sour) in different percentages are showed in Table 8. It is revealed from Table 8 that all results of treatments are highly significant ($p<0.01$) to each other.

Table 8: Effect of buttermilk on Ca, K and Na (mg) of muffins during storage

Treatments	Ca	K	Na
M_0	155.67D	577.23C	143.50D
M_1	173.00A	594.00AB	147.27A
M_2	170.00B	594.97A	146.37AB
M_3	164.33C	593.03B	145.43BC
M_4	164.00C	592.17B	144.50CD

The mean values for potassium content of muffin samples prepared with addition of buttermilk (sweet and sour) are mentioned in Table 8. The higher amount of potassium content was found in M_2 594.97 mg while least amount of potassium content was observed in M_0 577.23 mg. There was an increasing trend with the increased the buttermilk level in samples of muffins M_1 594 mg and M_2 594.97 mg in which 100% buttermilk is used. The mean values of potassium are in increasing trend in different treatments due to the increased the level of buttermilk in its formulation. The above discussion depicted that the muffins contained buttermilk have more contents of potassium due to the high level of minerals present in the buttermilk. The result was according to the findings of Spencer *et al*. (1991) who reported increase in potassium content in muffins.

Sodium content of muffins: The statistical analysis for sodium content of different samples of muffins prepared buttermilk (sweet and sour) in different percentages are showed in Table 8. Table 8 depicted that all results of treatments are highly significant ($p<0.01$) to each other.

The mean values for sodium content of muffin prepared with addition of buttermilk (sweet and sour) are presented in Table 8. The maximum value of sodium content was found in M_1 147.27 mg while least amount of sodium content was observed in M_0 143.50 mg. There was an increasing trend with the increased the buttermilk level in samples of muffins M_1 147.27 mg and M_2 146.37 mg in which 100% buttermilk is used. The overall mean values showed increasing trend regarding to the treatments in muffin prepared by the addition of buttermilk (sweet and sour).

The above discussion showed that the muffins prepared by buttermilk have more contents of sodium due to the high level of minerals present in the buttermilk. The result was according to the findings of Spencer *et al*. (1991) and Hassan *et al.* (2013) who were reported increase in sodium content in muffins.

Physical analysis

Textural analysis: Buttermilk (sweet and sour) based Muffins with varying concentration of buttermilk are subjected to textural analysis. The statistical results for the texture of different treatments of muffins prepared by buttermilk are mentioned in the Table 9. The statistical among treatments and storage period is highly significant ($p<0.01$). The interaction effect between treatments and storage of texture of muffins also observed highly significant ($p<0.01$).

The mean values for texture of different treatments of muffins prepared by the buttermilk are given in Table 9. In samples 0, 50 and 100% of buttermilk (sweet and sour) added in batter formulation of muffins showed force for compression considerably reduced due increase in the concentration of buttermilk (sweet and sour) in muffins. The value regarding to treatment varies 50.02-59.86 while respect to storage days it varies from 46.24-60.07. The force of compression increase with the storage due to reduction of moisture content.

It is clear from results that buttermilk based muffins containing high concentration of buttermilk shows high level of softness in texture and had low level of compression force. Difference is seemed in texture values of different treatments of muffins prepared by buttermilk. Data showed that compression force decreases from M_0 (49.86) than M_3 (47.10), M_4 (46.13), M_1 (44.76) to M_2 (43.36) at 0 day and same sequence of increasing of values from M_0 (65.60) than M_3 (60.70), M_4 (59.53), M_1 (59.20) to M_2 (55.33) at 7th day of storage. Results shows that use of buttermilk as replacer at 100% are beneficial for muffins of softer texture. The reason for this softness could be higher concentration of buttermilk. Storage showed highly significant results on texture of various treatments. These results are found similar with the finding of Sheare and Devies (2005), who reported that texture of flaxseed meal muffins become harder during storage.

Table 9: Effect of buttermilk on texture of muffins during storage

	Storage				
Treatments	0	3	5	7	Mean
M_0	49.86^{m}	59.76^{d}	64.23^{b}	65.60^{a}	59.86A
M_1	44.76^{q}	48.63^{n}	55.26^{i}	59.20^{f}	51.96D
M_2	43.36^{r}	48.76^{n}	52.63^{k}	55.33^{i}	50.02E
M_3	47.10^{o}	53.20^{j}	57.43^{g}	60.70^{c}	54.60B
M_4	46.13^{p}	52.30^{l}	56.83^{h}	59.53^{e}	53.70C
Mean	46.24D	52.53C	57.28B	60.07A	

Table 10: Effect of buttermilk on sensory properties of muffins

Treatments	Color	Flavor	Texture	Tenderness	Moistness	Shape	Overall acceptability
M_0	6.33^{a}	7.33^{a}	6.66^{a}	6.66^{b}	6.33^{c}	6.66^{a}	6.66^{b}
M_1	7.33^{ab}	7.00^{a}	7.66^{a}	7.00^{ab}	7.66^{ab}	7.66^{a}	6.66^{b}
M_2	7.66^{ab}	8.00^{a}	7.33^{a}	7.66^{a}	8.00^{a}	7.99^{a}	8.00^{a}
M_3	6.66^{ab}	7.66^{a}	7.66^{A}	7.33^{ab}	7.33^{abc}	7.00^{a}	7.00^{Ab}
M_4	7.33^{b}	7.55^{a}	7.00^{a}	7.00^{ab}	6.66^{bc}	7.33^{a}	7.33^{ab}

Sensory evaluation of muffins: Acceptability of the product was directly affected by the organoleptic properties of the product. Only the product is accepted for consumption that has good color, taste, flavor and appearance. The color, flavor, taste texture, appearance and overall acceptability are studied and sensory evaluation was performed at 0 day. The results of sensory properties of muffins are presented in Table 10.

Color of muffins: The sensory evaluation was performed for muffins were analyzed during storage of 0 day. Results showed that color score of product differed significantly among various treatments.

Flavor of muffins: The sensory evaluation was performed for muffins were analyzed during storage of 0 day. Results showed that flavor score of product differed significantly among various treatments.

Texture of muffins: The sensory evaluation was performed for muffins were analyzed during storage of 0 day. Results showed that texture score of product differed significantly among various treatments.

Tenderness: The sensory evaluation was performed for muffins were analyzed during storage of 0 day. Results showed that tenderness score of product differed significantly among various treatments.

Moistness: The sensory evaluation was performed for muffins were analyzed during storage of 0 day. Results showed that moistness score of product differed significantly among various treatments.

Shape: Results showed that shape score of product differed significantly among various treatments. There are significant changes among treatment interaction.

Overall acceptability: The sensory evaluation was performed for muffins were analyzed during storage of 0 day. Results showed that overall acceptability score of product differed significantly among various treatments.

CONCLUSION

The results of project concluded that, there is chance for value added, nutritious product like muffins prepared by buttermilk. Muffins contain all essential nutrients that are demand of market. The muffins (M_2) prepared by 100% sour buttermilk showed overall best results as compared to other treatments by judges and (M_1) treatment was best according to chemical analysis.

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