

## Effect of Levels of Buttermilk on Quality of Set Yoghurt

Ahmed JAO\* and Razig KAA

Department of Food Science and Technology, Faculty of Agriculture, AL-Zaeim AL-Azhari University, P.O. Box 1432 Khartoum North 13311, Sudan

### Abstract

The effect of different levels of buttermilk and storage period on quality of set yoghurt was investigated. Four batches of set yoghurt were prepared using; fresh cow milk and 3% skim milk powder (control), fresh cow milk, 2.5% skim milk powder and 5% buttermilk (sample A), fresh cow milk, 2.0% skim milk powder and 10% buttermilk (sample B), fresh cow milk, 1.5% skim milk powder and 15% buttermilk (sample C) and stored at 4°C for 15 days. The stored samples were examined for quality changes at 15 days interval. The results indicated that, the total solid, protein, fat and pH values of set yoghurt decreased significantly ( $P \leq 0.05$ ) as levels of buttermilk increased and storage time progressed.

Organoleptic quality of set yoghurt revealed that, 5% buttermilk scored the best appearance, texture, flavour and over all acceptability, followed by 0.0%, 10% and the worst was recorded for sample contains 15% buttermilk. Storage period significantly ( $P \leq 0.05$ ) affected the organoleptic quality of set yoghurt. The best score was obtained at the beginning of the storage period while the worst at the end.

**Keywords:** Set yoghurt; Buttermilk; Storage period

### Introduction

The worldwide consumption of milk or dairy products is constantly increasing. It is estimated that the production of milk increases about 1.5% every year in order to satisfy the needs of consumers. The increase of consumption of dairy products such as cheese or butter also increases the production of dairy by-products such as whey or buttermilk [1].

For many years, buttermilk has been considered as the invaluable by product of the milk fat industry. The worldwide production of buttermilk could be considered close to that of butter production [1].

Increasing the total solids in yoghurt milk to around 14-16 g 100 g<sup>-1</sup> is one of the essential steps in the process of yoghurt making. Traditionally, the fortification of the total solids in the yoghurt mix is achieved by boiling to reduce the volume of the milk to two-thirds of its original or by the addition of skimmed milk powder (SMP). Replacement of SMP with buttermilk powder up to 50% in the manufacture of low-fat yoghurt was found to be acceptable and similar to the control product [2].

Buttermilk powder when added to low-fat yoghurts up to 4.8% yielded a soft and smooth product [3]. Among the various dairy ingredients used in the manufacture of yoghurt, dried buttermilk was found to reduce the susceptibility of syneresis [4]. Milk powder (SMP) is used commonly to enrich yoghurt at a rate of 3 to 4% to increase the total solids [5]. One way to increase the demand for buttermilk is to find attractive uses for it as a cheese ingredient. Buttermilk has long been used as an ingredient in cheese making and there is growing interest in the cheese industry for cheeses with specific functional/nutritional properties, and ways to cost-effectively increase yield [6].

The high content of phospholipids in buttermilk makes it an important functional ingredient in an array of food products (e.g., chocolate, cheese seasoning, ice cream mixes and yoghurt) [7].

The objective of this investigation is to study the effect of levels of buttermilk on quality of set yoghurt.

### Material and Methods

Fresh cow milk, powdered skim milk, fresh buttermilk and yoghurt starter culture (*Streptococcus thermophilus* and *Lactobacillus delbrueckii*

subsp. *Bulgaricus*) were obtained from local dairy production factory; DAL Dairy factory, Khartoum. Sudan.

### Preparation and manufacture of set yoghurt

Four different blends of set yoghurt were produced using; fresh cow milk and 3% skim milk powder (control), fresh cow milk, 2.5% skim milk powder and 5% buttermilk (sample A), fresh cow milk, 2.0% skim milk powder and 10% buttermilk (sample B), fresh cow milk, 1.5% skim milk powder and 15% buttermilk (sample C).

The enriched mixes were stirred and heated to 85°C in thermo mix, with constant stirring for 25 minutes including ramp time. After cooling to 43°C in an ice water in thermo cooler, the milk was inoculated with a commercial yoghurt starter (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *Bulgaricus*) and filled in plastic cups then incubated at 43°C for 3-4 hours and the cups were transferred to refrigerator and stored at 5°C.

### Physiochemical analysis

The pH of samples was determined using electronic pH meter (JENWAY 3510 pH Meter, designed and manufactured in the UK by Bibby Scientific Stone LTD, model 3510, serial no. 51030).

The fat content and total solids content of the samples were determined according to the method described by the AOAC [8].

Proteins measured by Milkoscan, FOSS Analytical A/S.69, Slangeruggade, and DK3400 Hillerod Denmark.

\*Corresponding author: Jamal Abakar Osman Ahmed, Department of Food Science and Technology, Faculty of Agriculture, AL-Zaeim AL-Azhari University, Sudan, Tel: 249121234280; E-mail: [abakar.jamal@gmail.com](mailto:abakar.jamal@gmail.com)

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## Organoleptic quality

Twelve panelists were chosen to judge the quality of set yoghurt in term of appearance, flavour, texture and overall acceptability. The sensory evaluation of set yoghurt was evaluated by scoring procedure (hedonic scale) described by Ihekoronye and Ngoddy where 5: excellent, 4: very good, 3: good, 2: acceptable and 1: poor [9].

## Statistical analysis

The statistical analysis was performed using SAS system. Means were separated using Duncan's Multiple Range Test [10].

## Results and Discussion

### Physicochemical composition

**Total solid:** The highest value (14.48%) was obtained by the control sample. The lowest (14.01%) obtained by the set yoghurt containing 1.5% skim milk powder and 15% buttermilk (sample C) while the other samples ranked in an intermediate position ( $P \leq 0.05$ ). Storage period significantly ( $P \leq 0.05$ ) affected the total solid content. The total solid increased as the storage period progressed. The lowest value obtained at the beginning of the storage period while the highest at the end ( $P \leq 0.05$ ).

It was found that buttermilk added to the set yoghurt samples had lower total solid than the control samples. This result was in agreement with Bahrami et al. who found that as the proportion of sweet cream buttermilk increased, the percentage of total solids in the cream cheese fell, probably as a result of the decrease in total solids in the sweet cream buttermilk [11]. Pal et al., reported that the total solids of fat-free yogurt milk samples were significantly ( $P < 0.05$ ) reduced as a result of skimming. The result not in line with Pal et al. who found that the percentage of total solids decreased because of the presence of lipoprotein compounds, particularly phospholipids and membrane proteins; these compounds increase the water retention capacity and, thus, increase the moisture content [12].

It was observed that the total solid increased as the storage period progressed; the increased total solid level is probably a result of the release of whey during storage, this result was in agreement with Anjum et al. who reported that treatment and storage period had significant effect on the total solids of yoghurt samples prepared by locally isolated starter culture and commercial starter culture [13]. Kavas et al. reported that it is accepted that the increase during 14 days on total solids content was not significant and attributed to the evaporation, it's supported Akalin who reported that the increase determined during the storage period is normal [14,15].

Wang et al. reported that the reduction could be due to the utilization of sugar by the starter cultures [16,17]. It is evident from the result that reduction in total solids throughout storage period might be due to change of lactose into lactic acid by lactose fermenting bacteria in yoghurt. These results were confirmed Tamime and Robinson [5].

**Protein content (%):** The highest value (3.85%) was obtained by the control sample. The lowest (3.52%) by the set yoghurt containing 1.5% skim milk powder and 15% buttermilk (sample C) while the other samples ranked in an intermediate composition ( $P \leq 0.05$ ). Storage period significantly ( $P \leq 0.05$ ) affected the protein content. The protein content decreased as the storage period progressed. The highest value obtained at the beginning of the storage period while the lowest at the end ( $P \leq 0.05$ ) (Tables 1 and 2).

Results indicated that replacing buttermilk by SMP in set yoghurt samples had lower protein content than the control samples. These results are in agreement with the observation of Bahrami et al. who found that a comparison of the mean protein content showed that increasing sweet cream buttermilk in a mixture significantly decreased the amount of protein ( $p < 0.05$ ) [11]. As the percentage of sweet cream buttermilk increased, coagulation time increased and clots that were soft and delicate in texture were formed.

It was also noted that the protein content decreased as the storage period progressed; these results are in line with findings of Shanley who found that the protein contents of yoghurt decreased with the progress of storage period [18]. This is due to the fact that the majority of protein contents in milk decreased with storage. Also Galal et al. reported that the protein content during storage period decreased in all samples refer to decrease in total solids content during storage period and breakdown of amino acids by starter culture [19]. Serra et al., reported that in all treatments studied, caseins were hydrolyzed and hydrophobic peptides were increased during storage, as reflected by the increase in soluble nitrogen at the end of the storage [20].

The result disagree with Koestanti et al. who reported that during the fermentation process, the *Lactobacillus bulgaricus* and *Streptococcus thermophilus* microbe biomass were increased, thus the sum of microbe protein was increase, that automatically increasing protein inside the yoghurt [21].

**Fat content (%):** The highest value (3.21%) was obtained by the control sample. The lowest (2.82%) by the set yoghurt containing 1.5% skim milk powder and 15% buttermilk (sample C) while the other samples ranked in an intermediate composition ( $P \leq 0.05$ ). Storage period significantly ( $P \leq 0.05$ ) affected the fat content. The fat content decreased as the storage period progressed. The highest value obtained

Storage period (days)	Levels of Buttermilk			
	Control	A	B	C
0	14.28 ± 0.15 <sup>i</sup>	14.22 ± 0.18 <sup>k</sup>	14.15 ± 0.16 <sup>l</sup>	14.01 ± 0.19 <sup>l</sup>
3	14.36 ± 0.17 <sup>i</sup>	14.33 ± 0.13 <sup>g</sup>	14.24 ± 0.12 <sup>j</sup>	14.09 ± 0.11 <sup>l</sup>
6	14.37 ± 0.14 <sup>e</sup>	14.30 ± 0.20 <sup>k</sup>	14.30 ± 0.18 <sup>h</sup>	14.20 ± 0.21
9	14.44 ± 0.19 <sup>b</sup>	14.35 ± 0.22 <sup>g</sup>	14.34 ± 0.13 <sup>g</sup>	14.25 ± 0.16 <sup>h</sup>
12	14.45 ± 0.09 <sup>ab</sup>	14.39 ± 0.17 <sup>d</sup>	14.37 ± 0.16 <sup>e</sup>	14.31 ± 0.18 <sup>b</sup>
15	14.48 ± 0.21 <sup>a</sup>	14.45 ± 0.11 <sup>ab</sup>	14.40 ± 0.15 <sup>c</sup>	14.37 ± 0.14 <sup>e</sup>

\*Mean ± SD. having different superscript letters on columns and rows are significantly different ( $P \leq 0.05$ ).

Control ≡ set yoghurt with 3.0% skim milk powder and 0.0% buttermilk.

A ≡ set yoghurt with 2.5% skim milk powder and 5% buttermilk.

B ≡ set yoghurt with 2.0% skim milk powder and 10% buttermilk.

C ≡ set yoghurt with 1.5% skim milk powder and 15% buttermilk.

**Table 1:** Effect of levels of buttermilk and storage period on total solid (%) of set yoghurt.

at the beginning of the storage period while the lowest at the end ( $P \leq 0.05$ ) (Table 3).

The difference between the amounts of fat in different treatments was significant ( $P \leq 0.05$ ) because the proportion of fat in buttermilk was low, and this result agreed with Bahrami et al. [11]. This result is not in line with El Sayed et al. who studied the utilization of buttermilk concentrate in the manufacture of functional processed cheese spread and observed fat was higher in functional processed cheese incorporation of buttermilk concentrate, also fat in dry matter was increased in cheese spread containing 20 and 30% buttermilk concentrate [22]. The decrease of fat content with the progress of storage period could be attributed to the breakage of lipid during fermentation process, so that fat content decrease [23]. Also Abdel-Salam et al. found that, the fat content slightly decreased due to fat hydrolysis and liberation of free acids that escape determination by Girber method [24]. Tamime and Deeth reported a decrease in fat

content of yoghurt during storage period due to lipolysis in yoghurt [25]. The decreased level of fat is probably a result of the release of whey [26]. On the other hand this result was disagreed with Anjum et al., who reported that the fat content of yoghurt, displayed statistically not significant difference for reduction in fat content at the end of storage period that might be due to production of volatile fatty acids by yoghurt organisms [13].

**pH value:** The highest pH value (4.50) was obtained by the control sample. The lowest (4.07) by the set yoghurt containing 1.5% skim milk powder and 15% buttermilk (sample C) while the other samples ranked in an intermediate composition ( $P \leq 0.05$ ). Storage period significantly ( $P \leq 0.05$ ) affected the pH value. The pH value decreased as the storage period progressed. The highest pH value obtained at the beginning of the storage period while the lowest at the end ( $P \leq 0.05$ ) (Table 4).

Storage period (days)	Levels of Buttermilk			
	Control	A	B	C
0	3.85 ± 0.06 <sup>a</sup>	3.73 ± 0.03 <sup>b</sup>	3.69 ± 0.02 <sup>d</sup>	3.68 ± 0.01 <sup>e</sup>
3	3.82 ± 0.04 <sup>a</sup>	3.71 ± 0.07 <sup>c</sup>	3.63 ± 0.08 <sup>g</sup>	3.61 ± 0.09 <sup>h</sup>
6	3.73 ± 0.05 <sup>a</sup>	3.68 ± 0.11 <sup>e</sup>	3.62 ± 0.04 <sup>gh</sup>	3.59 ± 0.03 <sup>i</sup>
9	3.71 ± 0.12 <sup>c</sup>	3.67 ± 0.02 <sup>f</sup>	3.59 ± 0.07 <sup>i</sup>	3.57 ± 0.05 <sup>j</sup>
12	3.71 ± 0.08 <sup>c</sup>	3.62 ± 0.13 <sup>gh</sup>	3.59 ± 0.06 <sup>j</sup>	3.54 ± 0.11 <sup>kl</sup>
15	3.69 ± 0.13 <sup>d</sup>	3.57 ± 0.08 <sup>j</sup>	3.55 ± 0.09 <sup>k</sup>	3.52 ± 0.04 <sup>l</sup>

\*Mean ± SD. having different superscript letters on columns and rows are significantly different ( $P \leq 0.05$ ).

Control ≡ set yoghurt with 3.0% skim milk powder and 0.0% buttermilk.

A ≡ set yoghurt with 2.5% skim milk powder and 5% buttermilk.

B ≡ set yoghurt with 2.0% skim milk powder and 10% buttermilk.

C ≡ set yoghurt with 1.5% skim milk powder and 15% buttermilk

**Table 2:** Effect of levels of buttermilk and storage period on protein content (%) of set yoghurt.

Storage period (days)	Levels of Buttermilk			
	Control	A	B	C
0	3.21 ± 0.03 <sup>a</sup>	3.08 ± 0.01 <sup>e</sup>	3.02 ± 0.04 <sup>g</sup>	2.96 ± 0.02 <sup>i</sup>
3	3.20 ± 0.06 <sup>a</sup>	3.05 ± 0.07 <sup>f</sup>	2.98 ± 0.05 <sup>h</sup>	2.92 ± 0.08 <sup>jk</sup>
6	3.17 ± 0.11 <sup>b</sup>	3.05 ± 0.09 <sup>f</sup>	2.97 ± 0.06 <sup>hi</sup>	2.88 ± 0.13 <sup>j</sup>
9	3.16 ± 0.07 <sup>b</sup>	3.04 ± 0.12 <sup>f</sup>	2.97 ± 0.16 <sup>hi</sup>	2.86 ± 0.14 <sup>lm</sup>
12	3.13 ± 0.05 <sup>c</sup>	3.02 ± 0.11 <sup>g</sup>	2.94 ± 0.07 <sup>i</sup>	2.84 ± 0.12 <sup>lm</sup>
15	3.12 ± 0.13 <sup>d</sup>	3.02 ± 0.02 <sup>g</sup>	2.91 ± 0.09 <sup>k</sup>	2.82 ± 0.06 <sup>m</sup>

\*Mean ± SD. having different superscript letters on columns and rows are significantly different ( $P \leq 0.05$ ).

Control ≡ set yoghurt with 3.0% skim milk powder and 0.0% buttermilk.

A ≡ set yoghurt with 2.5% skim milk powder and 5% buttermilk.

B ≡ set yoghurt with 2.0% skim milk powder and 10% buttermilk.

C ≡ set yoghurt with 1.5% skim milk powder and 15% buttermilk

**Table 3:** Effect of levels of buttermilk and storage period on fat content (%) of set yoghurt.

Storage period (days)	Levels of Buttermilk			
	Control	A	B	C
0	4.50 ± 0.02 <sup>a</sup>	4.49 ± 0.04 <sup>b</sup>	4.48 ± 0.05 <sup>b</sup>	4.47 ± 0.06 <sup>c</sup>
3	4.38 ± 0.01 <sup>d</sup>	4.36 ± 0.03 <sup>de</sup>	4.35 ± 0.07 <sup>e</sup>	4.32 ± 0.08 <sup>fg</sup>
6	4.37 ± 0.05 <sup>de</sup>	4.33 ± 0.01 <sup>f</sup>	4.30 ± 0.06 <sup>g</sup>	4.28 ± 0.9 <sup>i</sup>
9	4.32 ± 0.07 <sup>fg</sup>	4.29 ± 0.11 <sup>h</sup>	4.28 ± 0.02 <sup>i</sup>	4.23 ± 0.03 <sup>j</sup>
12	4.28 ± 0.04 <sup>i</sup>	4.22 ± 0.06 <sup>k</sup>	4.22 ± 0.01 <sup>k</sup>	4.17 ± 0.02 <sup>m</sup>
15	4.20 ± 0.11 <sup>l</sup>	4.12 ± 0.08 <sup>n</sup>	4.11 ± 0.05 <sup>p</sup>	4.06 ± 0.03 <sup>p</sup>

\*Mean ± SD. having different superscript letters on columns and rows are significantly different ( $P \leq 0.05$ ).

Control ≡ set yoghurt with 3.0% skim milk powder and 0.0% buttermilk.

A ≡ set yoghurt with 2.5% skim milk powder and 5% buttermilk.

B ≡ set yoghurt with 2.0% skim milk powder and 10% buttermilk.

C ≡ set yoghurt with 1.5% skim milk powder and 15% buttermilk.

**Table 4:** Effect of levels of buttermilk and storage period on pH level of set yoghurt.

It was found that buttermilk added to the set yoghurt samples had slightly lower pH than control sample. This result goes with Romeih et al. who found that the pH reduction of fat-free yogurt with buttermilk powder addition was slightly faster even though those treatments showed slightly higher initial pH values.

It was observed that the pH value decreased as the storage period progressed. Fernandez-Garcia et al., found that the content of organic acids in yoghurt during fermentation and cooled storage of yoghurt continuously changed, and this affect pH of yoghurt during storage [27]. The pH-values were decreased progressively due to excessive sugar fermentation and presence of lactic acid [28]. It's supported El-abbassy et al. they found that the acidity increased and pH decreased gradually in yoghurt samples until the end of storage period [29].

**Sensory evaluation:** Set yoghurt containing 2.5% skim milk powder and 5% buttermilk recorded the best appearance (4.12), texture (3.84), flavour (3.80) and over all acceptability (4.07). Sample containing 1.5% skim milk powder and 15% buttermilk showed the worst (2.52, 2.36, 1.92 and 1.82) score respectively, while the other samples ranked in an intermediate position ( $P \leq 0.05$ ) (Table 5).

Storage period significantly ( $P \leq 0.05$ ) affected the sensory evaluation scores. The scores decreased as the storage period progressed. The highest scores obtained at the beginning of the storage period while the lowest at the end ( $P \leq 0.05$ ).

Trachoo et al. stated that non-fat and low fat set yoghurt prepared by enrichment with buttermilk powder (3.7% protein level) was smoother than those prepared with addition of skim milk powder (4% protein level) [3]. Low fat yoghurt with buttermilk powder found to be slightly smoother than the yoghurt with SMP. The appearance affected by the storage due to the change of color and this agree with Vargas et al., who reported that the compaction of the solid matrix and the increase in the syneresis index during storage explain these color change, it's also supported Hutchings who reported that the changes in color coordinates can be attributed to the different level of opacity [30,23].

Fortification of un-concentrated fresh buttermilk with skimmed milk powder or by ultrafiltration UF or nano-filtration (NF) is another

alternative to obtain good textural and sensory quality yoghurt [31]. The result was in accordance with Mumtaz et al. who reported that texture was affected significantly during storage in all experimental yoghurts [32]. The result was in disagreement with those of Radi et al. who reported that the different yoghurt samples showed similar texture after two weeks of storage as that of zero time [33]. Also it's supported by Herrero and Requena (2006) who found that the texture properties were maintained constant throughout the shelf- life of the product [34]. The result disagreed with that of Becker and Puhan (1989) they found that high protein content gives higher firmness values, indicating that this characteristic was not greatly affected by the different storage conditions [35].

The result observed confirmed the finding of Ekinici et al. who reported that, in general, the level of carbonyl compounds decreased during cold storage [36]. This could be associated further with metabolic activity of the starter cultures during the storage period. It's also supported Ozer and Radi et al. who reported that acetaldehyde, which is main flavor substance in yoghurt, metabolized to ethanol via alcohol dehydrogenase of *Streptococcus thermophiles* [37,33]. Flavor scores at zero time were significantly higher than of two weeks. Oberman found that diacetyl reductase enzyme becomes responsible for loss of the flavor after long storage [38]. Foda et al. reported that prolonging cold storage period affect the flavor significantly could be due to the strong taste [39]. The results were disagreement with that of Salvador and Fiszman they reported that no significant changes in relation to the storage time were found in color and flavor intensity for either type of yoghurt [40].

Guler et al. reported that; although it is not a common practice at industrial level, fortification of yoghurt mix with buttermilk powder may result in yoghurt with desired sensory and physical properties [41-49]. The level of buttermilk powder should not exceed 4.5-5.0% for acceptable yoghurt [3]. Replacement of SMP with buttermilk powder up to 50% in the manufacture of low-fat yoghurt was found to be acceptable and similar to the control product [2]. Buttermilk powder when added to low-fat yoghurts up to 4.8% yielded a soft and smooth product [3]. Among the various dairy ingredients used in the manufacture of yoghurt, dried buttermilk was found to reduce the susceptibility of syneresis [4].

Storage period (days)	Appearance				Texture				Flavour				Overall acceptability			
	levels of buttermilk															
	Control	A	B	C	Control	A	B	C	Control	A	B	C	Control	A	B	C
0	4.03 ± 0.06 <sup>a</sup>	4.12 ± 0.03 <sup>a</sup>	3.94 ± 0.11 <sup>b</sup>	3.70 ± 0.12 <sup>c</sup>	3.75 ± 0.7 <sup>b</sup>	3.84 ± 0.02 <sup>a</sup>	3.70 ± 0.05 <sup>b</sup>	3.47 ± 0.08 <sup>c</sup>	3.66 ± 0.03 <sup>ab</sup>	3.80 ± 0.05 <sup>a</sup>	3.52 ± 0.01 <sup>b</sup>	2.82 ± 0.04 <sup>h</sup>	3.89 ± 0.02 <sup>b</sup>	4.07 ± 0.04 <sup>a</sup>	3.52 ± 0.01 <sup>d</sup>	2.78 ± 0.03 <sup>k</sup>
3	3.63 ± 0.12 <sup>d</sup>	3.71 ± 0.14 <sup>bc</sup>	3.54 ± 0.09 <sup>e</sup>	3.33 ± 0.08 <sup>gh</sup>	3.38 ± 0.3 <sup>d</sup>	3.46 ± 0.04 <sup>c</sup>	3.33 ± 0.09 <sup>d</sup>	3.13 ± 0.02 <sup>g</sup>	3.29 ± 0.07 <sup>d</sup>	3.42 ± 0.02 <sup>c</sup>	3.17 ± 0.11 <sup>ef</sup>	2.54 ± 0.09 <sup>i</sup>	3.50 ± 0.08 <sup>d</sup>	3.67 ± 0.06 <sup>c</sup>	3.17 ± 0.07 <sup>e</sup>	2.50 ± 0.04 <sup>m</sup>
6	3.38 ± 0.13 <sup>g</sup>	3.46 ± 0.11 <sup>f</sup>	3.31 ± 0.08 <sup>h</sup>	3.11 ± 0.07 <sup>i</sup>	3.15 ± 0.06 <sup>f</sup>	3.23 ± 0.11 <sup>e</sup>	3.11 ± 0.13 <sup>g</sup>	2.92 ± 0.04 <sup>i</sup>	3.07 ± 0.08 <sup>ef</sup>	3.19 ± 0.04 <sup>e</sup>	2.96 ± 0.09 <sup>g</sup>	2.37 ± 0.06 <sup>n</sup>	3.27 ± 0.06 <sup>f</sup>	3.42 ± 0.08 <sup>b</sup>	2.96 ± 0.04 <sup>i</sup>	2.33 ± 0.02 <sup>n</sup>
9	3.22 ± 0.05 <sup>j</sup>	3.45 ± 0.04	3.29 ± 0.06 <sup>j</sup>	2.96 ± 0.09 <sup>kl</sup>	3.00 ± 0.05 <sup>hi</sup>	3.07 ± 0.12 <sup>h</sup>	2.96 ± 0.02 <sup>hi</sup>	2.78 ± 0.07 <sup>k</sup>	2.93 ± 0.12 <sup>g</sup>	3.04 ± 0.06 <sup>f</sup>	2.81 ± 0.03 <sup>hi</sup>	2.26 ± 0.05 <sup>o</sup>	3.11 ± 0.09 <sup>h</sup>	3.26 ± 0.11 <sup>f</sup>	2.81 ± 0.12 <sup>j</sup>	2.22 ± 0.09 <sup>o</sup>
12	2.98 ± 0.16 <sup>k</sup>	3.05 ± 0.13 <sup>j</sup>	2.91 ± 0.07 <sup>i</sup>	2.74 ± 0.04 <sup>n</sup>	2.78 ± 0.09 <sup>k</sup>	2.84 ± 0.08 <sup>j</sup>	2.74 ± 0.06 <sup>j</sup>	2.57 ± 0.11 <sup>n</sup>	2.71 ± 0.06 <sup>j</sup>	2.81 ± 0.08 <sup>hi</sup>	2.60 ± 0.12 <sup>k</sup>	2.09 ± 0.13 <sup>o</sup>	2.88 ± 0.07 <sup>i</sup>	3.01 ± 0.09 <sup>h</sup>	2.60 ± 0.11 <sup>i</sup>	2.06 ± 0.12 <sup>o</sup>
15	2.74 ± 0.11 <sup>n</sup>	2.80 ± 0.12 <sup>m</sup>	2.68 ± 0.05 <sup>o</sup>	2.52 ± 0.14 <sup>p</sup>	2.55 ± 0.13 <sup>no</sup>	2.61 ± 0.14 <sup>m</sup>	2.52 ± 0.08 <sup>o</sup>	2.36 ± 0.12 <sup>p</sup>	2.49 ± 0.11 <sup>m</sup>	2.58 ± 0.07 <sup>i</sup>	2.39 ± 0.04 <sup>mn</sup>	1.92 ± 0.08 <sup>p</sup>	2.64 ± 0.05 <sup>j</sup>	2.77 ± 0.07 <sup>k</sup>	2.39 ± 0.03 <sup>n</sup>	1.89 ± 0.08 <sup>p</sup>

\*Mean ± SD. having different superscript letters on columns and rows are significantly different ( $P \leq 0.05$ ).  
Control ≡ set yoghurt with 3.0% skim milk powder and 0.0% buttermilk.  
A ≡ set yoghurt with 2.5% skim milk powder and 5% buttermilk.  
B ≡ set yoghurt with 2.0% skim milk powder and 10% buttermilk  
C ≡ set yoghurt with 1.5% skim milk powder and 15% buttermilk

**Table 5:** Effect of levels of buttermilk and storage period on sensory evaluation scores of set yoghurt.



## References

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