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Effect of Types of Probiotic Bacteria on Physiochemical Properties of Sudanese White Soft Cheese

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Abstract

The study was conducted to assess the effect of three different types of probiotic bacteria (*Lactobacillus rhamnosus*, *Lactobacillus casei* and *Bifidobacterium bifidum*) on quality of Sudanese white soft cheese. The objectives of this study were to study the effect of three types of probiotic bacteria on the quality of Sudanese white soft cheese during different storage periods. The samples were subjected to physicochemical parameters, microbial examination. The result of physiochemical parameters showed increase in the yield. The highest yield obtained by cheese containing probiotic bacteria in comparing with control. The moisture content in all cheese samples decreased, while the weight loss, protein, fats and ash content increased during storage period ($p \leq 0.05$). The pH values decreased, while the titratable acidity increased and both parameters were affected significantly ($p \leq 0.05$) by the types of probiotic bacteria. The soluble nitrogen, formol ripening index, schilovich ripening index and total volatile fatty acids increased significantly during storage period, the highest values observed by samples containing probiotic bacteria comparing with control. The highest calcium, phosphorus, sodium, potassium, magnesium, iron was obtained by sample containing probiotic bacteria comparing with control.

Keywords: Probiotic bacteria, Sudanese white soft cheese, storage period.

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1. Introduction

Probiotic as a term is a relatively new word meaning for life and it is currently used to describe a group of bacteria when administered insufficient quantity, confer beneficial effects for humans and animal [1]. Probiotic bacteria are applied to balance disturbed intestinal microflora and important in the treatment of a wide range of human disorders including lactose intolerance, diarrhea, food allergies, intestinal infection, constipation gastroenteritis, hepatic, flatulence, colitis, gastric acidity, osteoporosis, high blood cholesterol and cancer [2, 3]. The most organisms used as probiotic belong to *bifidobacteria*, *Lactobacillus* and some *Enterococcus* ssp. [4]. Lactic acid bacteria (LAB) and bifidobacteria are amongst the most important groups of microorganisms used in the food industry, used in the production of fermented products, such as yoghurts, cheese and pickled vegetables [5].

Bifidobacteria spp. beneficially affects human health by improving the balance of intestinal microflora and improving mucosal defenses against pathogens. Additional health benefits include enhanced immune response, reduction of serum cholesterol, vitamin synthesis, anti-carcinogenic activity, and anti-bacterial activity [6, 7]. *Lacticobacillus casei* improvement of balance of intestinal microbiota and volatile fatty acid, antitumor action, stimulation of the immune system, and antimicrobial activity [8]. *Lactobacillus rhamnosus* benefits are reducing the activity of fecal enzymes such as *β*-glucuronidase and azoreductase which contribute to the risk of colon, mammary, and prostate cancer [9]. *Lactobacillus rhamnosus* increases the number and the activity of natural killer cells and exerts immunostimulating effects, including on fetuses [10]. Cheese is known as a complete nutritious food product and excellent source of many key nutrients, suitable for many ages. It is rich in protein and minerals such as calcium. There are different types of cheese: soft cheese, semi hard and hard cheese, the difference in these types is mainly due to water content or water activity and the methods and technology for cheese making [11].

The major traditional cheese types produced in Sudan include Gibna Bayda, Gibna Mudaffra and Mozarella and Romi cheese [12]. Cheese making in Sudan is the major preservation method for surplus milk in rural areas especially during rainy season when plenty of milk is available [13]. The Sudanese Gibna Bayda (white cheese) has a unique, very originated and traditional technology, and can be categorized as white-brined soft cheese [14]. White pickled cheese of the Sudan is a product traditionally made from raw milk to which salt (6-20%) has been added. White cheese is usually made from raw milk and without the use of starter culture [15].

The objective of this investigation is to study the effect of three types of probiotic bacteria (*lactobacillus rhamnosus, lactobacillus casei*, *Bifidobacteria bifidum*) on physiochemical of Sudanese white soft cheese.

2. Materials and Methods

Milk: Fresh cow's milk was obtained from Alarabia Company, Khartoum North, Sudan.

Clotting agent: Rennet tablets were obtained from (Chr.Hansens Lab., Copenhagen, Denmark).

probiotic bacteria: Freeze-dried of commercial strains cultures (*Bifidobacterium bifidum, Lactobacillus casei, and Lactobacillus rhamnosus*) were obtained from (Chr.Hansens Lab., Copenhagen, Denmark).

Salt and package: Fine powder salt **(**sodium chloride) and polyethylene packs were obtained from the local market in Khartoum North, Sudan.

2.1. Cheese manufacture

Sudanese white soft cheese was processed using fresh cow's milk according to the method of [15]. Cheese was manufacturing in faculty of agriculture lab, ALzaiem ALazhari University.

First milk was purified from foreign particles, then was pasteurized to72°C for 1 minute, and cooled to 40°C. Milk was divided into four separate tanks (A, B, C, D) each one contained 10 L, (A) left as a control, 2g of probiotics bacteria (*Bifidobacterium bifidum, Lactobacillus casei and Lactobacillus rhamnosus*) were added to each tank (B, C, D) at 40ºC respectively. Followed by the addition of $CaCl_2$ (0.02%) and rennet (0.2g). Milk was stirred for 5 minutes and then left undistributed to develop a curd. After the coagulated was completed, the curd was cut into cups with an ordinary stainless steel kitchen knife to allow whey separation. The curd was kept for about 20-30 minutes for whey drainage. The whey of each tank was collected and kept in a cold environment over night. The curd was transferred to clean wooden molds lined with cheese cloth and pressed with about 1 Kg over night. Next day the curd was removed from the molds, weighed and cut into rectangular of 160 gm each. 6% w/v NaCl was added to the collected whey, then pasteurizing at 72°C for 1 minute, and added to cheese curd into sterile plastic buckets. Cheese was stored at room temperature (38±2°C) for 60 days. Physico- chemicals, microbiological and organoleptic characteristics were carried out at 0,15,30,45 and 60 days intervals [15].

2.2. Physicochemical analysis:

Cheese samples were analyzed for titratable acidity, protein, fat, ash, according to [16]. The pH meter (model. A005673-3-5). Moisture content and soluble nitrogen were determined according to [17]. Formol and Schilovich ripening index According to [18]. Minerals Determined according to [19]. Total volatile fatty acids Determined according to [20]. Fatty acids contents were measured by GC-MS model (GC.MS-QP2010 Ultra, Japan).

2.3. Statistical analysis:

Data were analyzed as complete randomized design with three replicates using statistical analysis system program [21]. Means were separated using Duncan's Multiple Range Test.

3. Result and discussion:

The three types of probiotic bacteria (*Lactobacillus rhamnosus, Bifidobacterium bifidum* and *Lactobacillus casei*) effected the physiochemical properties of Sudanese white soft cheese manufactured from fresh cow's milk, for example titrable acidity increased with the addition of the probiotic bacteria, the highest TA (1.90%) was obtained by cheese samples containing *Lactobacillus rhamnosus*. The lowest (1.28%) by the control samples while the other samples ranked in an intermediate position ($p \leq 0.05$) as shown in table 1. This increase in titratable acidity may be due to the activity of proteinases and peptidases released from the experimental strains (probiotic strains), which resulted in higher proteolysis in cheese [22]. [23] observed that titratable acidity increased in all samples of Karish Cheese as affected of probiotic *Bifidobacterium bifidum* and

L.rhamnosus during days of storage. [24] said that titratable acidity increased in all samples of probiotic fresh white cheese with *L.rhamnosus* and *L.casei* during a storage period. Increase in acidity of Sudanese white soft cheese reported by [25] as probably due to growth of lactic acid bacteria in cheese.

Table 1: Effect of types of probiotic bacteria on titratable acidity (%) of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	**Lactobacillus rhamnosus**	**Lactobacillus casei**
0	0.53^{M}±0.05	0.60^{L}±0.03	0.66^{k} ±0.07	0.63^{kL}±0.06
15	0.79^{J}±0.02	0.86^{i}±0.11	0.97^{g} ±0.04	0.93^{h}±0.12
30	0.83^{i}±0.08	0.95^{gh}±0.09	1.13^{e} ±0.02	1.11^{ef}±0.03
45	1.00^{f}±0.03	1.38^{d}±0.06	1.70^{b} ±0.05	1.57^{c}±0.04
60	1.28^{d}±0.09	1.65^{c}±0.12	1.90^{a} ±0.08	1.73^{b}±0.11

- Mean ± SD. Having different superscript letters on columns and rows are significantly different (P≤0.05)

Also the three types of bacteria affected the protein content during the storage period. The highest (19.04%) was obtained by cheese samples containing *lactobacillus rhamnosus*. The lowest (18.75%) by the control samples, while the other samples ranked in an intermediate position (p≤0.05) as shown in Table 2. The protein content increased with the addition of the probiotic bacteria. [26] found that protein content increased in Dutch-type cheese and cheese-Like products with the addition of *L.rhamnosus*. [27] found that, the protein content of Sudanese semi braided cheese content increased during storage period due to the loss of moisture.

Table 3. Shows the effect of probiotic bacteria on fat content of the Sudanese white soft cheese during storage period. The highest (26.98%) fat content was obtained by the cheese samples containing *lactobacillus rhamnosus*. The lowest (25.70%) by the control samples, while the other samples ranked in an intermediate position (p≤0.05). The fat content increase in all cheese samples due to the loss of moisture content during storage period. The same trend of these results was reborted by [28, 22 ,29].

Table 4. Shows the effect of type of probiotic bacteria on ash content during storage period. The highest (4.70%) ash content obtained by the control samples. The lowest (3.00%) by the cheese samples containing *Lactobacillus rhamnosus*, while the other samples ranked in an intermediate position (p≤0.05). [30] found the ash content increased in Sudanese white soft cheese with starter culture. [31] conducted that ash content increased in soft cheese in Kariesh cheese made using probiotic bacteria. [15] reported that ash contents

increased in Sudanese white soft cheese "Gibna Beida" as storage time advanced.

Table 2: Effect of types of probiotic bacteria on protein content (%) of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	Lactobacillus rhamnosus	Lactobacillus casei
0	16.72^{m}±0.06	17.03 ^{L}±0.09	17.16^{kL}±0.08	16.91 ^{m}±0.07
15	17.47^{kL}±0.07	18.11 ^{Ji}±0.05	18.24 ^{hi}±0.03	17.86 ^{k}±0.04
30	18.18^{i}±0.05	18.43^{g} ±0.03	18.50 ^{g}±0.03	18.37 ^{h}±0.11
45	18.82^{d}±0.09	18.82 ^{d}±0.09	18.88 ^{c}±0.06	18.69 ^{f}±0.02
60	18.75^{e}±0.04	18.94^{b} ±0.09	19.04 ^{a}±0.04	18.88 ^{c}±0.12

- Mean ± SD. Having different super script letters on columns and rows are significantly different (P≤0.05)

Table 3: Effect of types of probiotic bacteria on fat content (%) of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	Lactobacillus rhamnosus	Lactobacillus casei
0	21.40^{L}±0.02	22.92^{k}±0.06	23.45^{h}±0.03	22.30^{J}±0.04
15	22.52^{k}±0.01	23.83^{i}±0.07	24.83^{e}±0.05	23.63^{gh}±0.08
30	23.00^{J}±0.05	24.47^{gh}±0.11	25.90^{b}±0.09	24.80^{e}±0.06
45	24.70^{g}±0.07	25.30^{f}±0.08	26.53^{a}±0.12	25.82^{c}±0.11
60	25.70^{f}±0.04	26.00^{d}±0.03	26.98^{a}±0.13	25.97^{bc}±0.02

- Mean ± SD. Having different superscript letters on columns and rows are significantly different (P≤0.05)

Table 4: Effect of types of probiotic bacteria on ash content (%) of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	**Lactobacillus rhamnosus**	**Lactobacillus casei**
0	2.70^{hi}±0.15	2.30^{k}±0.09	1.00^{L}±0.11	2.45^{J}±0.13
15	3.00^{g}±0.11	2.60^{i}±0.19	1.40^{J}±0.16	2.85^{h}±0.09
30	3.90^{e}±0.13	3.50^{f}±0.08	2.10^{g}±0.14	3.72^{e}±0.12
45	4.45^{bc}±0.12	4.00^{d}±0.07	2.54^{f}±0.15	4.20^{cd}±0.16
60	4.70^{a}±0.16	4.25^{c}±0.17	3.00^{d}±0.18	4.55^{b}±0.19

- Mean ± SD. Having different superscript letters on columns and rows are significantly different (P≤0.05)

Also pH values effect by the three types of probiotic bacteria, the highest (4.05) pH value was obtained by the control samples. The lowest value (3.55) by the cheese samples containing *Lactobacillus rhamnosus* as shown in table 5. [32] conducted that pH decreased in Feta cheese made with a probiotic culture. Cheese making is based on application of LAB in the form of defined or undefined starter cultures that are expected to cause a rapid acidification of milk through the production of lactic acid, with the consequent decrease in pH values [33]. [34] stated that in Turkish Beyaz cheese supplemented with probiotic bacteria was lower in pH than the control without probiotic.

Table 5: Effect of types of probiotic bacteria on pH value of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	**Lactobacillus rhamnosus**	**Lactobacillus casei**
0	5.50^{a}±0.02	4.95^{b}±0.06	4.73^{bc}±0.07	4.48^{bc}±0.05
15	5.10^{a}±0.05	4.64^{c}±0.03	4.28^{e}±0.08	4.47^{d}±0.12
30	4.58^{d}±0.04	4.15^{ef}±0.09	4.10^{gh}±0.11	4.17^{g}±0.06
45	4.22^{f}±0.11	4.00^{h}±0.02	3.69^{iJ}±0.05	3.88^{i}±0.07
60	4.05^{gh}±0.03	3.77^{iJ}±0.12	3.55^{Jk}±0.04	3.65^{J}±0.08

- Mean ± SD. Having different superscript letters on columns and rows are significantly different (P≤0.05)

Moisture content effect by the types of probiotic bacteria during storage period. The highest (50.36%) moisture obtained by sample containing *Lactobacillus rhamnosus*. The lowest (47.34%) by the control samples. The highest values obtained at the beginning of the storage period while the lowest at the end ($p \leq 0.05$) as shown in table 6. Decreased in moisture might be due to the development of acidity, which leads to curd contraction that helps to expel the whey from the curd [35]. [36] pointed that moisture content of probiotic cheese supplemented with *Lactobacillus casei*, *Bifidobacterium lactis* all types of cheese revealed a natural loss of moisture upon 60 days of ripening. Results are in agreement with those reported by [37]. [38] reported that probiotic supplementation of Panela Cheese containing *L.rhamnosus* showed greater decreased in moisture.

Table 6: Effect of types of probiotic bacteria on moisture content (%) of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	Lactobacillus rhamnosus	Lactobacillus casei
0	$55.69^{de} \pm 0.15$	$56.72\ ^{c}\pm0.12$	$58.57^{a} \pm0.11$	$57.59\ ^{b}\pm0.11$
15	$52.93^{fg}\pm0.19$	$54.66\ ^{f}\pm0.16$	$55.97\ ^{d}\pm0.15$	$55.13\ ^{e}\pm0.15$
30	$49.81^{Jk}\pm0.13$	$51.11^{h} \pm0.17$	$53.57^{fg} \pm0.14$	$52.85\ ^{g}\pm0.16$
45	$48.1^{LM}\pm0.14$	$49.89\ ^{J}\pm0.18$	$51.98\ ^{h}\pm0.09$	$50.88\ ^{i}\pm0.13$
60	$47.34^{M}\pm0.19$	$48.12^{L} \pm0.21$	$50.36\ ^{i}\pm0.12$	$49.23\ ^{k}\pm0.17$

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

Table 7. Shows the effect of types of probiotics on soluble nitrogen (SN) of Sudanese white soft cheese during storage period, the highest (0.78%) obtained by cheese samples containing *Lactobacillus rhamnosus*. The lowest (0.52%) by the control samples. Increased in SN of soft cheese could be due to the enzymes released by probiotic cultures during the pickling [39]. [23] observed that SN increased in all samples of Karish Cheese as affected by the probiotic *B.bifidum* and *L.rhamnosus* during days of storage. [40] reported that SN increased in probiotic white brined cheese with *L.casei* during the storage period. [41] enumerated that SN % increased with addition of *L. rhamnosus* in Kareish cheese during storage of the samples.

Also Formol Ripening Index (FRI) effect by the types of probiotic bacteria during storage period. The highest FRI (48.88mg/100g cheese) obtained by cheese samples containing *Lactobacillus rhamnosus*. The lowest (39.68mg/100g cheese) by the control samples. The lowest values obtained at the beginning of the storage period while the highest at the end ($p \leq 0.05$). As shown in table 8. These results could be attributed to the presence of proteolytic and lipolytic system of probiotic strains [42]. [43] stated that the salting method had a significant effect on FRI of Ras cheese. Increasing ripening index with the time is in agreement with that reported by [12, 44].

Table 7: Effect of types of probiotic bacteria on soluble nitrogen content (SN) (%) of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	Lactobacillus rhamnosus	Lactobacillus casei
0	0.20^{L}±0.06	0.30^{J}±0.03	0.34^{i}±0.04	0.32^{J}±0.07
15	0.27^{K}±0.01	0.37^{h}±0.05	0.37^{g}±0.02	0.38^{h}±0.09
30	0.34^{i}±0.08	0.43^{fg}±0.07	0.43^{e}±0.06	0.47^{f}±0.05
45	0.42^{fg}±0.04	0.61^{d}±0.02	0.61^{c}±0.08	0.63^{cd}±0.11
60	0.52^{e}±0.03	0.72^{b}±0.08	0.78^{ab}±0.05	0.77^{ab}±0.04

- Mean ± SD. Having different superscript letters on columns and rows are significantly different (P≤0.05)

Table 8: Effect of types of probiotic bacteria on formol ripening index (FRI) (mg/100g cheese) of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	Lactobacillus rhamnosus	Lactobacillus casei
0	15.08^{p}±0.15	18.22^{NO}±0.13	22.26^{L}±0.13	19.00^{N}±0.12
15	17.80^{O}±0.16	20.78^{m}±0.11	27.80^{J}±0.23	24.34^{K}±0.14
30	21.32^{LM}±0.19	29.00^{i}±0.12	32.39^{g}±0.25	30.25^{h}±0.42
45	31.80^{gh}±0.18	36.68^{f}±0.21	39.62^{d}±0.16	38.00^{e}±0.17
60	39.68^{d}±0.17	42.00^{c}±0.14	48.88^{a}±0.19	46.92^{b}±0.11

- Mean ± SD. Having different superscript letters on columns and rows are significantly different (P≤0.05)

Also Schilovich Ripening Index (SRI) effect by the three types of probiotic bacteria. The highest (60.32mg/100g cheese) SRI was obtained by cheese samples containing *Lactobacillus rhamnosus*. The lowest (49.83mg/100g cheese) by the control samples, table 9. [30] found the SRI content increased in Sudanese white soft cheese with starter culture. SRI increased from 18.80 to 31.33at the end of storage period. [22] stated that SRI of probiotic Domiati cheese supplemented with different levels of *L.rhamnosus* increased during ripening period. [45] conducted the increased of SRI during ripening of Swiss cheese affecting by adjunct cultures.

Table 9: Effect of types of probiotic bacteria on schilovich ripening index (SRI) (mg/100g cheese) of white soft cheese during storage period.

Storage period (Days)	**Control**	**Types of probiotic bacteria**		
		Bifidobacterium bifidum	**Lactobacillus rhamnosus**	**Lactobacillus casei**
0	$23.89^{O}\pm0.19$	$30.86^{N}\pm0.18$	$34.80^{L}\pm0.23$	$32.22^{m}\pm0.25$
15	$30.53^{N}\pm0.26$	$35.20^{L}\pm0.16$	$40.20^{J}\pm0.15$	$36.55^{k}\pm0.21$
30	$42.37^{iJ}\pm0.22$	$43.35^{i}\pm0.14$	$46.17^{gh}\pm0.24$	$45.16^{h}\pm0.13$
45	$47.70^{g}\pm0.11$	$54.56^{e}\pm0.27$	$59.22^{b}\pm0.19$	$56.70^{d}\pm0.22$
60	$49.83^{f}\pm0.17$	$56.55^{d}\pm0.16$	$60.32^{a}\pm0.14$	$57.98^{c}\pm0.23$

- Mean ± SD. Having different superscript letters on columns and rows are significantly different (P≤0.05)

In the minerals content as shows in Table 10. the three types of probiotic bacteria effect minerals in Sudanese white soft cheese as follows:

a- Calcium content**:** The highest calcium content (9.80 mg/l) was obtained by the cheese sample containing *L.rhamnosus*. The lowest (7.96 mg/l) by the control sample. [46] conducted the ionization yield of mineral compounds, mostly calcium, increases with a decrease in pH. [47] conducted that feeding rats of probiotic cheese resulted in increased calcium retention compared to control. [48] noticed that calcium content increased in white soft cheese (jibna-beida) prepared by using starter culture (LAB).

b- Phosphorous content: The highest phosphorous content (3.62 mg/l) was obtained by the cheese sample containing *L.rhamnosus*. The lowest (3.30 mg/l) by the control sample. [49] reported that phosphorous content increased in Dairy product with addition of *B.bifidum*. The addition of *L.rhamnosus* led to a minor increase (2%) in phosphorus availability. [46] conducted that the rate of changes in the pH of cheese was one of the key determinants of phosphorus availability. The ionization yield of mineral compounds increases with a decrease in pH.

c- Sodium content: The highest sodium content (57.80 mg/l) was obtained by sample containing *L.rhamnosus*. The lowest (56.51mg/l) by the control sample. [48] stated thet sodium content increased in white soft cheese (jibna-beida) prepared by using starter culture (LAB). [50] observed that the sodium content of *B.bifidum* in some dairy products was 52mg/100g. [12] stated that the sodium content of braided cheese increased.

d- Pottasium content: The highest pottasium content (7.98 mg/l) was obtained by the cheese sample containing *L.rhamnosus*. The lowest (6.33 mg/l) by the control sample. [48] stated the pottasium content increased in white soft cheese (jibna-beida) prepared by using starter culture (LAB). The stimulating effect of probiotic cultures on the availability of mineral compounds in cheese can be attributed to intensified enzymatic conversion, mainly proteolysis and lipolysis. [51, 52, 53].

e- Magnesium content: The highest magnesium content (7.69 mg/l) was obtained by sample containing *L.rhamnosus*. The lowest (6.00 mg/l) by the cheese sample containing control. [54] conducted that milk magnesium content was high. [46] found that availability of magnesium from Dutch-type cheese with probiotics *L. rhamnosus.* The addition of probiotic culture resulted in increase in the availability of magnesium relative to control at 24, 20, and 10%, respectively. [55] stated the availability of magnesium from various ripe cheeses is also determined by proteolysis and lipolysis products.

f- Iron content: The highest iron content (1.35 mg/l) was obtained by the cheese sample containing *L.rhamnosus*. The lowest (1.18 mg/l) by the control sample. [50] stated that the amount of iron content in *B.bifidum* in some dairy product was 0.46mg. The stimulating effect of probiotic cultures on the availability of mineral compounds in cheese can be attributed to intensified enzymatic conversion, mainly proteolysis and lipolysis [51, 52, 53]. [56] reported that *B.animals* and *B.breve* dairy product appear to enhance micronutrient absorption (particularly iron) and bone development, but the effect appear to be highly dependent on the probiotic strain.

Table 10: Effect of types of probiotic bacteria on minerals contents (mg/L) of white soft cheese

Minerals Mg/L	**Control**	**Types of probiotic bacteria**		
		Bifidobacterium bifidum	**Lactobacillus rhamnosus**	**Lactobacillus casei**
Calcium	$7.96^{c}\pm0.07$	$8.92^{b}\pm0.09$	$9.80^{a}\pm0.11$	$9.15^{a}\pm0.05$
Phosphorous	$3.30^{d}\pm0.04$	$3.42^{c}\pm0.06$	$3.62^{a}\pm0.05$	$3.55^{b}\pm0.09$
Sodium	$56.51^{b}\pm0.06$	$56.66^{b}\pm0.03$	$57.80^{a}\pm0.02$	$57.12^{a}\pm0.04$
Potassium	$6.33^{c}\pm0.07$	$6.68^{b}\pm0.08$	$7.98^{a}\pm0.04$	$6.72^{bc}\pm0.05$
Magnesium	$6.00^{d}\pm0.02$	$6.82^{b}\pm0.04$	$7.69^{a}\pm0.06$	$6.63^{c}\pm0.08$
Iron	$1.18^{c}\pm0.03$	$1.27^{b}\pm0.02$	$1.35^{a}\pm0.07$	$1.23^{c}\pm0.06$

- Mean ± SD. Having different superscript letters on rows are significantly different (P≤0.05)

The Total volatile fatty acidscontent (TVFA) effect by three types of probiotic bacteria during storage period. The highest (39.00 mls 0.1NaoH/100Kg cheese) TVFA was obtained by cheese samples containing *Lactobacillus rhamnosus*. The lowest (17.00 mls0.1NaoH/100Kg cheese) by the control samples.as ahown in table 11. [57] conducted the increased in TVFA of probiotic Ras cheese supplemented with different levels of *L.rhamnosus* during ripening. [58] found the TVFA increased in Edam cheese supplemented with *B.bifidum* as well as control during storage period. [59] stated that TVFA of cheese increased during the storage period from 23.00 (0.1 N ml NaOH/100 g cheese) at the beginning of the storage period to 50.00 (0.1 N ml NaOH/100 g cheese) at 90 days of storage in white soft cheese. [60] reported increase in TVFA in Domiati cheese effect of some lactic acid bacteria.

Table 11: Effect of types of probiotic bacteria on total volatile fatty acids (TVFA) (mls 0.1N NaoH/100kg cheese) of white soft cheese during storage period.

Storage period (Days)	Control	Types of probiotic bacteria		
		Bifidobacterium bifidum	Lactobacillus rhamnosus	Lactobacillus casei
0	$10.20^{P}\pm0.08$	$11.00^{O}\pm0.04$	$14.03^{L}\pm0.11$	$12.00^{N}\pm0.03$
15	$11.22^{O}\pm0.06$	$13.22^{m}\pm0.07$	$18.00^{i}\pm0.02$	$16.56^{g}\pm0.12$
30	$14.28^{L}\pm0.03$	$20.00^{h}\pm0.05$	$25.20^{f}\pm0.06$	$23.00^{g}\pm0.07$
45	$15.00^{JK}\pm0.09$	$29.08^{e}\pm0.08$	$32.00^{cd}\pm0.04$	$31.00^{d}\pm0.11$
60	$17.00^{iJ}\pm0.05$	$33.17^{c}\pm0.06$	$39.00^{a}\pm0.07$	$37.00^{b}\pm0.03$

- Mean ± SD. Having different superscript letters on columns and rows are significantly different (P≤0.05)

3. Conclusion

The effect of probiotic bacteria (*L.rhamnosus, L.casei* and *B.bifidium*) on physiochemical properties of Sudanese white soft cheese made from cow's milk was investigated. Evaluations of physicochemical properties were carried out at 0,15,30,45 and 60 days interval.

- A significant (p≤0.05) increased in level of the titratable acidity during storage of cheese coupled with a concomitant decrease in pH values particularly by addition of probiotic bacteria.
- Major components of Sudanese white soft cheese such as fat and protein increased by the addition of probiotic bacteria during storage period.
- There was increased in SN, SN/TN, FRI, SRI and TVFA during storage period in all probiotic samples.
- Minerals content and fatty acids increased in all treated samples.

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