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Physicochemical, microbiological and Sensory Characteristics of White Soft Cheese Made with Different Strains

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Abstract

Probiotic products are important functional foods as they represent about 65% of the world's functional food market. Probiotic bacteria have been incorporated into various foods, including dairy products like cheese. White soft cheese is healthy and beneficial for human nutrition, especially if made with probiotics, which have many health benefits. This study aimed to manufacture full-fat white soft cheese and recognize its chemical, physical, antioxidant, microbial, and sensory properties. Soft cheese prepared with different treatments, prepared with rennet (C), yoghurt starter (T1), mixed probiotic bacteria culture (Bifidobacteria breve and Lactobacillus plantarum) (T2), Bifidobacteria breve culture (T3) and Lactobacillus plantarum culture (T4) during storage period for 21 days at refrigerator temperature. The chemical composition of soft cheese treatments indicated that the highest mean values of total solids, protein, and fat were for T2 treatment, with significant differences between other treatments. The lowest mean of lactose was for T2 treatment. The lowest pH value was detected in the T1 compared to other cheese treatments for fresh and during the storage period. The highest pH value was detected in the control sample in all periods of storage time. The highest value of DPPH was for T2. The highest mean values of acid value, peroxide number, and TBA were for the control sample, and the lowest mean value was for the T2. The highest mean value was at the end of the storage period. Total bacterial counts, psychrophilic bacteria, Str. thermophilus, Lb. delbrueckii ssp. bulgaricus, Bifidobacteria breve, and Lactobacillus plantarum of different cheese treatments increased during the storage period of 21 days, then decreased during 21 days. Sensory evaluation indicated that the highest mean value of the overall acceptability for treatments was for the control cheese, followed by T1, T4, T2, and T3, respectively.

Key words: Probiotic bacteria, *Lactobacillus plantarum*, *Bifidobacteria breve*, Soft cheese, chemical composition, microbial analysis

INTRODUCTION

Cheese represents one of the most popular food products in the world. This is probably thanks to its richness in nutritional components like proteins, short-chain FAs, vitamins (e.g., riboflavin, thiamin, vitamin B12), and minerals, e.g., calcium, phosphorus [1]. Cheese is recognized to be of great nutritional value for human consumption. Protein in cheese has a high

biological value, and cheese contains all essential amino and fatty acids. As well as it is a good source of minerals and vitamins [2].

Calve rennet used in cheese manufacturing was and still is the most widely used. It is milk-clotting enzyme preparation, which is extracted from the calf's fourth stomach of claves before its weaning [3]. Using calf rennet for milk coagulation is the most procedure used in cheese making. However, the worldwide increase in cheese production, reduced supply, and increasing calf rennet prices have led to the search for alternative milk clotting enzymes as an appropriate rennet substitute [4].

Cheeses have many numbers of advantages over other fermented products, such as yoghurt as a delivery system for a helpful probiotic to the gastrointestinal tract in that cheeses tend to have high acidity and more solid consistency where the matrix of the cheese and its relatively high-fat content may offer protection to probiotic bacteria during passage through the gastrointestinal tract. Cheeses also have high buffering capacity than yoghurt [5].

Commercial interest in functional food containing probiotic strains has consistently increased due to the awareness of the benefits for gut health, disease prevention, and therapy [5]. However, modern consumers expect their food to be healthy and to prevent illness as they are increasingly interested in their health.

Probiotics are usually used in dairy products. As well as cheese is a good vehicle for these microorganisms. Besides the viability of probiotics in cheese, the incorporation of probiotic bacteria mustn't affect the expected sensory characteristics (flavour, appearance, and texture) of conventional (non-probiotic) cheeses. Although several studies have shown probiotic starters didn't considerably affect the sensory quality of cheese, it is thought that their addiction might contribute to different flavour and texture characteristics [6].

Consumers are interested in functional products that contribute to limiting the risks of diseases, so there is a growing market for foods, including probiotics. Probiotic food products are described as "Functional foods," which commonly gain popularity and acceptance throughout developed countries [7].

Therefore, the main objective of this work was to investigate the potential effect of prebiotics with rennet coagulant on the chemical, physical and microbial characteristics of white soft cheese.

MATERIALS AND METHODS

2.1. Materials

- Fresh whole raw cow's milk (87.23% moisture, 3.38% protein, 4.02% fat, 4.66% lactose, and 8.75% SNF) was used in this research, obtained from the herd of the Faculty of Agriculture, Cairo University. Hannilase rennet powder (CHY- Max extra) was purchased from Chr. Hansen' s Lab., Denmark.Commercial fine-grade salt from El-Gomhoria Company, Egypt. Probiotic starter (*Bifid. breve* and *L. plantarum*) were obtained from Cairo Microbiological Resources Center, Faculty of Agriculture, Ain Shams University, Cairo, Egypt. Yoghurt starter (*L. delbrueckii subsp. bulgaricus and S. thermophilus*) were obtained from Cairo Microbiological Resources Center, Faculty of Agriculture, Ain Shams University, Cairo, Egypt.

2.2. Methods

2.2.1. White soft cheese manufacturing

In this research, five groups of functional white soft

cheese were manufactured according to the method adopted by Mahmoud et al. [8]. Fresh cow's milk was standardized to contain 4.02% fat and 8.75% SNF, heat treated to 80oC for 10 min, and then cooled to 40oC. Milk was divided into five equal portions, the first portion was prepared with rennet enzyme (control), and the remaining portions were prepared with the addition of 4 different starter cultures. Four starter cultures were prepared in 12% sterile reconstituted skim milk powder (RSMP).

Experimental design as the following table 1:

Table (1): Types and ratios of starters used in different treatments in soft cheese manufacturing

Treatments	Rennent %	Yoghurt starter 1:1	*B. breve* & *L. plantarum* 1:1	*B. breve*	*L. plantarum*
Control	0.4	-	-	-	-
T1	0.4	2%	-	-	-
T2	0.4	-	2%	-	-
T3	0.4	-	-	2%	-
T4	0.4	-	-	-	2%

Four milk portions were inoculated, allowing for the strains' propagation and acid production for 1 h. Then salted all portions with 3% NaCl, stirred well, added the rennet at the rate of 0.4% (V/V) milk, and left to complete coagulation. The curd is ladled into rectangular frames (20x25cm), lined with cloth. The curd was pressed, and the drained whey was collected. The resulting functional white soft cheeses were cut into cubes, packaged into plastic containers (capacity 150 cm), and stored at 4 ± 1oC for 21 days. The experiments were carried out in triplicate. Samples of each functional white soft cheese were withdrawn when fresh and after 7, 14, and 21 days of storage for chemical, physical, bacteriological, and organoleptic analysis. Data were reported as the average of three independent trials.

2.2.2. Physicochemical analyses

The moisture, protein, fat, ash, lactose total acidity (as lactic acid), and pH according to **AOAC [9].** The micro-Kjeldahl method was used to determine soluble nitrogen (SN) and total nitrogen (TN) content, and protein content was obtained by multiplying the percentage of TN by 6.38, fat content was measured by the Gerber method and ash by heating a 5g sample in a muffle furnace at100^{o}C for 1hour, 200 ^{o}C for 2 hours and ashing at 550 ^{o}C overnight. DM in cheese samples was determined using a drying oven and calculated as follows: %DM= 100 - % moisture**.** The salt content of cheese was estimated using the Volhard method, according to **Richardson [10].**

2.2.3. Lipid oxidation

To determine lipid oxidation in white soft cheese samples, acid, peroxide, and TBA values were determined at storage days of 0, 7, 14, and 21 days using the standard method of **AOCS [11].**

2.2.3. DPPH radical scavenging activity:

The determination of antioxidant activity through the DPPH scavenging system was carried out according to the method of **Musa [12]**. A stock solution was prepared by dissolving 40 mg DPPH in 100 mL methanol and kept at -20°C until used. About 350 µL stock solution was mixed with 350 µL methanol to obtain the absorbance 516 nm wavelength using a spectrophotometer (Epoch, Biotek, USA). About 100 µL cheese extracts with 1 mL methanolic. The DPPH solution prepared was kept overnight for scavenging reaction in the dark. The percentage of DPPH scavenging activity was

determined as follows: DPPH scavenging activity (%) = $A_{blank} - A_{sample}/A_{blank} \times 100$. Where A is the absorbance.

2.2.4. Microbial analyses

Ten grams of cheese samples were homogenized with 90 mL of sterile Pepton water 0.1g 100 ml–1 with a stomach. Decimal dilutions in peptone water were made and plated on standard plate count agar medium (Oxoid) for total viable bacterial counts (TC) and psychrophilic bacterial count, according to **Houghtby *et al*. [13]**. The plates were incubated at 37 ±2°C for 48 h and 4 for 48 h, respectively.

- M17-lactose agar for *S. thermophilus* (Merck, Germany) [14]**.**
- MRS agar medium for *L. delbrukii* sub sp *bulgaricus* according to [15]**.**
- Modified MRS agar medium (m-MRS), supplemented with 0.05% L-Cysteine HCl and 0.3% lithium chloride for *B. breve*
- LPSM (*L. plantarum* selective medium) for *L. plantarum*, [16]**.** MRS plates were incubated in anaerobic conditions for 48 h at 37 °C, while M17 plates were incubated in aerobic conditions for 48 h at 37°C.

2.2.5. Sensory evaluation

The cheese samples were organoleptically scored using a score card for flavour (50 points), body and texture (35 points), and appearance & colour 15 points). This was done by some trained panellists selected from experienced residents of teaching and staff of the Department of Food Science- faculty of Home Economic – Al-Azhar University [17].

2.2.6. Statistical analysis:-

The obtained data were statistically analyzed for analysis of the variance average and Duncan's test according to the SPSS computer program **SPSS [18].**

RESULTS AND DISCUSSION

Chemical composition of white soft cheese is prepared by different strains of probiotic bacteria during the storage period

Data presented in Table 2 show the chemical properties of white soft cheese s processed by rennet (C), yoghurt starter (T_1), Mixed probiotic bacteria culture (*Bifidobacteria breve* and *Lactobacillus plantarum*) (T_2), *Bifidobacteria breve culture* (T_3) and *Lactobacills plantarum* culture (T_4) during storage periods for 21 days at refrigerator temperature. The highest mean of TS was T2 (36.68). This increase may be due to the constriction of the curd due to increasing the acidity, which aids in whey expulsion from the curd. The TS content of white soft cheese increased with significant differences during the storage periods up to 21 days in all treatments. That is may be due to loss of moisture during the storage period. These results agree with **Soliman and Zaki [19],** who made probiotic cheese with *Bif. bifidum + L. casei* & cheese made from *Bif. bifidum + L. acidophilus*.

The mean protein content of cheese for the T1 sample was the lowest value (14.09%) and the highest value for the sample (T_2) for fresh and during storage time. Protein content increased with significant differences during refrigerator storage periods of up to 21 days for all treatments. This increase could be due to the increase in TS content. These results agreed with **Effat *et al.* [20],** who made low-salt soft cheese supplemented with *Pediococcus pentosaceus, Lactobacillus rhamnosus,* and *Pediococcus acidilactici*. The lowest mean value of fat content was for the control sample (14.99%), and the highest fat value

was for T_2 (15.29%). Differences between treatments with nominal mean fat values increased during the storage period (21 days) with significant differences. The lowest mean of ash was for T_1 and T_2 treatments (2.55%), and the highest value of ash was for T_4 (3.03%). The means of ash increased significantly during the storage period (21 days). The lactose content of cheese was the highest for the control sample (3.44%) compared with different cheese treatments with probiotic bacteria. The lowest mean of lactose was for the T_2 sample (3.14%). This may be due to lactose fermentation to lactic acid produced by *Bifidobacteria breve* and *Lactobacillus plantarum*. Means of lactose-reduced with significant differences for all treatments during the storage period (21 days). May be due to increased lactic acid, as lactose fermentation increases acidity. These results agree with **Garcia *et al.* [21]**, who made probiotic goat whey cheeses using *Lactobacillus rhamnosus* and Bifidobacterium animals, as well as thyme essential oil and sodium citrate.

The lowest mean of salt content was for the control sample (2.05%). There were no significant differences between other treatments. The salt increased significantly during the storage period (21 days) may be due to the increase of total solids in cheese during the storage period (21 days). These results were in agreement with **Kebary *et al.* [22].** The mean of control samples had lower salt values in white soft cheese .

Table 2. Chemical composition of white soft cheese prepared with different probiotic bacteria strains during the storage period.

Storage Periods (Days)	Treatments				
		T1	T2	T3	T4
Total solid (%)					
Fresh	34.46±0.04	35.32±0.05	35.38±0.03	35.45±0.05	35.30±0.04
7	35.20±0.05	36.02±0.07	36.08±0.04	36.15±0.03	35.98±0.06
14	35.80±0.04	36.62±0.05	36.66±0.05	36.77±0.04	36.60±0.05
21	36.93±0.04	37.75±0.04	37.78±0.04	37.89±0.05	37.73±0.03
Protein (%)					
Fresh	13.88 ±0.04	13.85±0.04	14.11±0.04	13.90±0.04	13.92±0.04
7	14.03±0.03	13.97±0.03	14.24±0.05	14.01±0.03	14.06±0.05
14	14.22±0.03	14.13±0.04	14.41±0.06	14.19±0.05	14.26±0.06
21	14.51±0.05	14.40±0.05	14.70±0.05	14.48±0.05	14.50±0.05
Fat (%)					
Fresh	14.64±0.05	14.70±0.05	14.82±0.04	14.65±0.05	14.71±0.04
7	14.80±0.05	14.94±0.03	15.16±0.05	14.82±0.04	14.92±0.05
14	14.80±0.06	14.94±0.06	15.16±0.06	14.82±0.03	14.92±0.03

21	15.40±0.05	15.53±0.04	15.74±0.04	15.43±0.05	15.48±0.05
Ash (%)					
Fresh	2.25±0.02	2.27^{Da}±0.03	2.22^{Ca}±0.03	2.26^{Ca}±0.03	2.27^{Da}±0.03
7	2.39^{Cd}±0.04	2.42^{Cd}±0.04	2.64^{Bc}±0.03	2.81^{Bb}±0.04	3.10^{Ca}±0.05
14	2.58^{Bb}±0.03	2.64^{Ba}±0.03	2.66^{Bb}±0.05	2.85^{Ba}±0.05	3.63^{Ba}±0.04
21	2.81^{Ac}±0.05	2.85^{Ab}±0.05	2.77^{Ad}±0.04	2.88^{Ab}±0.04	3.84^{Aa}±0.06
Lactose (%)					
Fresh	3.58^{Aa}±0.04	3.36^{Ac}±0.05	3.28^{Ad}±0.04	3.45^{Ab}±0.05	3.39^{Ac}±0.05
7	3.52^{Ba}±0.03	3.29^{Bd}±0.06	3.21^{Be}±0.05	3.39^{Bb}±0.05	3.32^{Bc}±0.04
14	3.44^{Ca}±0.05	3.22^{Cc}±0.04	3.13^{Cd}±0.06	3.31^{Cb}±0.04	3.25^{Cc}±0.06
21	3.23^{Da}±0.06	3.10^{Db}±0.03	2.94^{Dc}±0.05	3.19^{Da}±0.06	3.14^{Db}±0.05
Salt (%)					
Fresh	1.98^{Da}±0.04	2.02^{a}±0.04	2.03^{Da}±0.05	2.01^{Da}±0.04	2.01^{Da}±0.04
7	2.04^{Ca}±0.05	2.08^{Ca}±0.05	2.09^{Ca}±0.04	2.07^{Ca}±0.05	2.06^{Ca}±0.04
14	2.06^{Bb}±0.06	2.13^{Ba}±0.04	2.15^{Ba}±0.06	2.10^{Ba}±0.04	2.11^{Ba}±0.05
21	2.13^{Ab}±0.04	2.20^{Aa}±0.04	2.23^{Aa}±0.04	2.18^{Aa}±0.03	2.17^{Ab}±0.07

$^{(A-D)}$ Different uppercase superscripts represent significant differences in the same column ($P < 0.05$)

$^{(a-e)}$ Different lowercase superscripts represent significant differences in the same row ($P < 0.05$)

where: C: Control: Cheese with 0.4% rennet

T_1: Cheese with 2% yoghurt starter culture (*Str. thermophilus + Lb. delbrueckii* ssp. *bulgaricus* (1:1).

T_2: Probiotic cheese with 2% (*Bifidobacteria breve* and *Lactobacillus plantarum*) (1:1)).

T_3: Probiotic cheese with 2% *Bifidobacteria breve culture*.

T_4: Probiotic cheese with 2% *Lactobacillus plantarum* culture

pH and acidity of white soft cheese prepared with different strains of probiotic bacteria during the storage period.

Results in Figure 1 illustrate the pH values of the different treatments of cheese made with different probiotic bacteria. The lowest pH value was detected in the T_2 (*Bifidobacteria breve* and *Lactobacillus plantarum* 1:1) sample, compared to other cheese treatments for fresh and during the storage period (21 days). The highest pH value was detected in the control sample in all periods of storage time. Fig.2 shows the acidity of different treatments of cheese made with different probiotics. The control samples (C) had lower acidity compared to other cheese treatments for fresh and during storage periods. The differences among cheese treatments in acidity might be due to the growth rate of *Bifi. Breve* and *Lactobacillus plantarum* for T_2 and growth of *Str. thermophilus + Lb. delbrueckii*) for T_1 and the ability to ferment lactose during storage time. These results agreed with **Soliman and Zaki [19],** who studied cheese made from *Bif. Bifidum*, *L.* casei, *L. acidophilus* and *L. johnsonii* during 28 days.

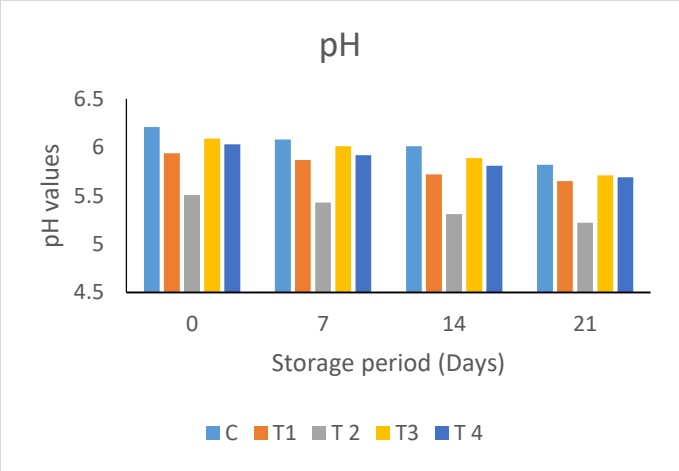

Figure 1. pH of white soft cheese prepared with different strains of probiotic bacteria during storage period at 4 ± 1 ºC.*As written under table 2.

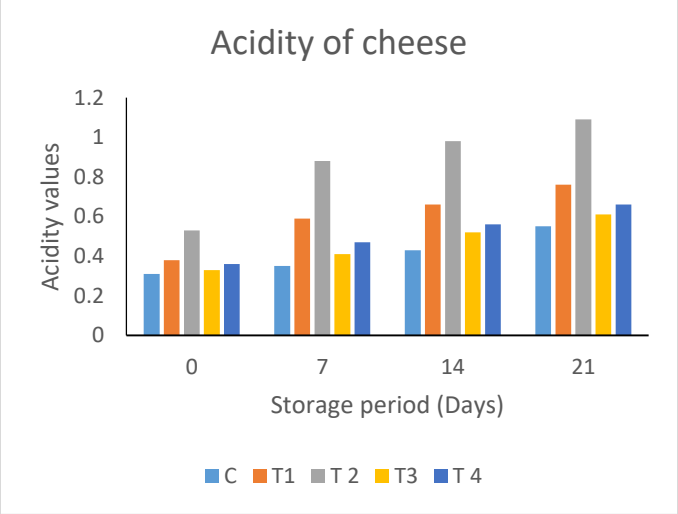

Figure 2. Acidity of white soft cheese prepared with different strains of probiotic bacteria during the storage period at 4 ± 1 ºC.*As written under table 2.

DPPH values of white soft cheese prepared with different strains of probiotic bacteria during the storage period.

Fig.3 shows DPPH values of white soft cheese prepared different strains of probiotic bacteria during the storage period. The results indicated that the control sample had the lowest DPPH value for all storage time (21 days). DPPH value of T_1 treatment *Str. thermophilus* + *Lb. delbrueckii* ssp. *bulgaricus* (1:1) was higher than the control sample. The highest value of DPPH was for T_2 (*Bifidobacteria breve* and *Lactobacillus plantarum*). DPPH of T_4 cheese made with (*Lactobacillus plantarum*) culture (T_4) was higher than T_3 cheese made with (*Bifidobacteria breve*). Fermented dairy products contain bioactive components that are essential in reducing the effect of reactive oxygen species produced by oxidative stress in cells [24]**.** These results were in agreement with **Mushtaq *et al.* [25],** who studied the effect of antioxidants on probiotics *(Lactobacillus plantarum, Lactobacillus casei,* and *Lactobacillus brevis* in Himalayan cheese.

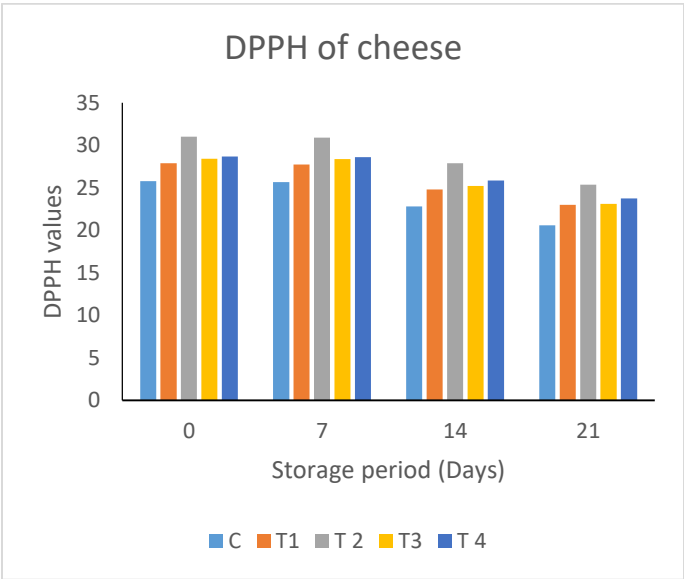

Figure 3. DPPH values of white soft cheese prepared with different strains of probiotic bacteria during the storage period at 4 ± 1 ºC.*As written under table 2.

Effect of different probiotic bacteria strains on white soft cheese 's lipid oxidation properties during the storage period.

Table (3) shows lipid oxidation, including acid value, peroxide number, and TBA of soft cheese with probiotic bacteria during the storage period (21 days). The highest values of acid value and

peroxide number were for the control sample and the lowest for the T_2 sample (*Bifidobacteria breve* and *Lactobacillus plantarum*). The highest value was at the end of the storage period (21 days). There were no significant differences between TBA values for treatments and during the storage period. It may be due to a short storage period. These results might be due to the high antioxidant capacity (DPPH) of T_2. There were significant differences between the control sample and other treatments with probiotic bacteria. These results were in agreement with **Mushtaq *et al*. [26].**

Table (3). Effect of different probiotic bacteria strains on white soft cheese's lipid oxidation properties during storage at 4 ± 1 ºC**.**

Storage Periods (Days)	Treatments				
	C	**T_1**	**T_2**	**T_3**	**T_4**
Acid Value(mg/g)					
Fresh	0.68^{Da}±0.01	0.62^{Cb}±0.01	0.49^{De}±0.01	0.58^{Dc}±0.01	0.52^{Cd}±0.01
7	0.70^{Ca}±0.01	0.64^{Cb}±0.02	0.51^{Ce}±0.01	0.60^{Cc}±0.02	0.54^{Cd}±0.01
14	0.84^{Ba}±0.02	0.78^{Bb}±0.01	0.64^{Be}±0.01	0.73^{Bc}±0.02	0.71^{Bd}±0.01
21	1.02^{Aa}±0.01	0.92^{Ab}±0.02	0.79^{Ae}±0.02	0.89^{Ac}±0.01	0.83^{Ad}±0.01
Peroxide Number (meqO_2/ Kg)					
Fresh	3.86^{Da}±0.01	3.79^{Db}±0.01	3.22^{De}±0.01	3.45^{Dc}±0.01	3.38^{Dd}±0.01
7	4.11^{Ca}±0.01	3.89^{Cb}±0.02	3.45^{Ce}±0.02	3.61^{Cc}±0.01	3.50^{Cd}±0.01
14	4.86^{Ba}±0.02	4.71^{Bb}±0.01	4.16^{Be}±0.01	4.53^{Bc}±0.01	4.45^{Bd}±0.02
21	5.77^{Aa}±0.02	5.62^{Ab}±0.01	5.10^{Ae}±0.01	5.39^{Ac}±0.02	5.28^{Ad}±0.01
TBA (mg/kg fat)					
Fresh	0.17^{Aa}±0.01	0.17^{Aa}±0.01	0.14^{Aa}±0.01	0.16^{Aa}±0.02	0.16^{Aa}±0.01
7	0.17^{Aa}±0.01	0.17^{Aa}±0.01	0.14^{Aa}±0.01	0.16^{Aa}±0.02	0.16^{Aa}±0.01
14	0.18^{Aa}±0.01	0.17^{Aa}±0.02	0.15^{Aa}±0.02	0.17^{Aa}±0.01	0.16^{Aa}±0.02
21	0.19^{Aa}±0.02	0.18^{Aa}±0.01	0.15^{Aa}±0.01	0.17^{Aa}±0.01	0.17^{Aa}±0.01

$^{(A-D)}$ Different uppercase superscripts represent significant differences in the same column ($P < 0.05$)

$^{(a-e)}$ Different lowercase superscripts represent significant differences in the same row ($P < 0.05$)

*As written under Table 2.

Microbial analysis of white soft cheese prepared with different strains of probiotic bacteria during the storage period.

Table 4 results indicated that the means values of total bacterial counts and psychrophilic bacteria of different cheese treatments increased during the storage period (21days). Development leading to the inhibition of bacteria in cheese [27, 21]**.** The total count for T_2 was the highest value for all times of storage with significant differences compared with other treatments.

Table 4. Microbial analysis of white soft cheese prepared with different strains of probiotic bacteria during the storage period.

Storage Periods (Days)	Treatments				
	C	**T_1**	**T_2**	**T_3**	**T_4**
Total bacterial count (log CFU/g)					
Fresh	3.32^{Dd}±0.03	7.91^{Db}±0.01	7.21^{Dc}±0.02	8.57^{Da}±0.03	8.55^{Da}±0.03
7	4.62^{Ce}±0.03	8.11^{Cc}±0.04	7.41^{Cd}±0.03	8.88^{Cb}±0.03	8.98^{Ca}±0.03
14	5.23^{Ad}±0.02	8.31^{Ab}±0.03	8.12^{Ac}±0.02	9.61^{Aa}±0.02	9.98^{Aa}±0.02
21	5.12^{Be}±0.04	7.50^{Bd}±0.03	7.91^{Bc}±0.03	9.21^{Bb}±0.03	9.60^{Ba}±0.03
Psychrophilic bacteria (log CFU/g)					
Fresh	2.68^{Da}±0.03	2.45^{Db}±0.01	2.38^{Dc}±0.03	2.12^{Dd}±0.02	2.10^{Dd}±0.03
7	3.10^{Ca}±0.02	2.92^{Cb}±0.03	2.88^{Cc}±0.03	2.60^{Cd}±0.03	2.45^{Ce}±0.02
14	3.97^{Aa}±0.03	3.83^{Ab}±0.03	3.76^{Ac}±0.02	3.45^{Ad}±0.04	3.92^{Aa}±0.03
21	3.15^{Be}±0.04	3.76^{Ba}±0.04	3.50^{Bb}±0.03	3.40^{Bd}±0.02	3.46^{Bc}±0.02
***Lactobacillus bulgaricus* (log CFU/g)**					
Fresh	ND	6.68^{D}±0.05	ND	ND	ND
7	ND	7.02^{C}±0.06	ND	ND	ND
14	ND	7.98^{A}±0.07	ND	ND	ND
21	ND	7.24^{B}±0.05	ND	ND	ND
***Streptococcus thermophilus* (log CFU/g)**					
Fresh	ND	6.20^{D}±0.05	ND	ND	ND
7	ND	6.32^{C}±0.04	ND	ND	ND
14	ND	6.81^{A}±0.03	ND	ND	ND
21	ND	6.42^{B}±0.06	ND	ND	ND
***Bifidobacterium breve* (log CFU/g)**					
Fresh	ND	ND	7.11^{Db}±0.04	8.23^{Da}±0.05	ND
7	ND	ND	7.53^{Cb}±0.05	8.42^{Ca}±0.03	ND
14	ND	ND	7.83^{Ab}±0.05	9.52^{Ac}±0.04	ND
21	ND	ND	7.57^{Bb}±0.06	8.92^{Ba}±0.05	ND
***Lactobacillus plantarum* (log CFU/g)**					
Fresh	ND	ND	7.18^{Db}±0.06	ND	8.32^{Da}±0.04
7	ND	ND	7.62^{Cb}±0.05	ND	8.52^{Ca}±0.05
14	ND	ND	7.84^{Ab}±0.04	ND	9.42^{Aa}±0.04
21	ND	ND	7.72^{Bb}±0.03	ND	9.33^{Ba}±0.03
Storage Periods (Days)	**Treatments**				
	C	**T_1**	**T_2**	**T_3**	**T_4**

Total bacterial count (log CFU/g)					
Fresh	3.32^{Dd}±0.03	7.91^{Db}±0.01	7.21^{Dc}±0.02	8.57^{Da}±0.03	8.55^{Da}±0.03
7	4.62^{Ce}±0.03	8.11^{Cc}±0.04	7.41^{Cd}±0.03	8.88^{Cb}±0.03	8.98^{Ca}±0.03
14	5.23^{Ad}±0.02	8.31^{Ab}±0.03	8.12^{Ac}±0.02	9.61^{Aa}±0.02	9.98^{Aa}±0.02
21	5.12^{Be}±0.04	7.50^{Bd}±0.03	7.91^{Bc}±0.03	9.21^{Bb}±0.03	9.60^{Ba}±0.03
Psychrophilic bacteria (log CFU/g)					
Fresh	2.68^{Da}±0.03	2.45^{Db}±0.01	2.38^{Dc}±0.03	2.12^{Dd}±0.02	2.10^{Dd}±0.03
7	3.10^{Ca}±0.02	2.92^{Cb}±0.03	2.88^{Cc}±0.03	2.60^{Cd}±0.03	2.45^{Ce}±0.02
14	3.97^{Aa}±0.03	3.83^{Ab}±0.03	3.76^{Ac}±0.02	3.45^{Ad}±0.04	3.92^{Aa}±0.03
21	3.15^{Be}±0.04	3.76^{Ba}±0.04	3.50^{Bb}±0.03	3.40^{Bd}±0.02	3.46^{Bc}±0.02
***Lactobacillus bulgaricus* (log CFU/g)**					
Fresh	ND	6.68^{D}±0.05	ND	ND	ND
7	ND	7.02^{C}±0.06	ND	ND	ND
14	ND	7.98^{A}±0.07	ND	ND	ND
21	ND	7.24^{B}±0.05	ND	ND	ND
***Streptococcus thermophilus* (log CFU/g)**					
Fresh	ND	6.20^{D}±0.05	ND	ND	ND
7	ND	6.32^{C}±0.04	ND	ND	ND
14	ND	6.81^{A}±0.03	ND	ND	ND
21	ND	6.42^{B}±0.06	ND	ND	ND
***Bifidobacterium breve* (log CFU/g)**					
Fresh	ND	ND	7.11^{Db}±0.04	8.23^{Da}±0.05	ND
7	ND	ND	7.53^{Cb}±0.05	8.42^{Ca}±0.03	ND
14	ND	ND	7.83^{Ab}±0.05	9.52^{Ac}±0.04	ND
21	ND	ND	7.57^{Bb}±0.06	8.92^{Ba}±0.05	ND
***Lactobacillus plantarum* (log CFU/g)**					
Fresh	ND	ND	7.18^{Db}±0.06	ND	8.32^{Da}±0.04
7	ND	ND	7.62^{Cb}±0.05	ND	8.52^{Ca}±0.05
14	ND	ND	7.84^{Ab}±0.04	ND	9.42^{Aa}±0.04
21	ND	ND	7.72^{Bb}±0.03	ND	9.33^{Ba}±0.03

$^{(A-D)}$ Different uppercase superscripts represent significant differences in the same column ($P < 0.05$)

$^{(a-e)}$ Different lowercase superscripts represent significant differences in the same row ($P < 0.05$)

*As written under Table 2.

Lactobacillus bulgaricus and *Str. thermophilus* counts in T_1 treatment increased with significant differences until the first 14 days and reduced after 14 to 21 days of storage. Higher counts of *Lactobacillus bulgaricus* compared with *Str. thermophilus* could be attributed to the ability of the genus Lactobacillus to survive at high acidity compared with counts of the Streptococci genus. These results agreed with **Effat *et al.* [7],** who studied functional white soft cheese with probiotic

bacteria. The growth of *B.* ***breve*** and *L. plantarum* for T_2, T_3, and T_4 treatment increased during the first 14 days and decreased after 14 days to 21 days. It may be due to increased acidity during storage time (21 days). These results agreed with **Mahmoud *et al.* [8],** who studied the effect of probiotic bacteria on Karish Cheese production.

Sensory properties of probiotic white soft cheese during refrigeration at 5°C for 21 days.

The sensory evaluation results in Table (5) included colour, appearance**,** body and& texture, flavour, and overall acceptability for different cheese treatments made with probiotic bacteria during the storage period (21 days). The highest mean value of the overall acceptability for treatments was for T_2 , and decreased during the storage period (21 days).

Table 5. Sensory properties of probiotic white soft cheese, during refrigeration period at 5°C for 21 days.

Storage Periods (Days)	Treatments				
	C	T_1	T_2	T_3	T_4
Color and appearance (15)					
Fresh	14^{Aa}	14^{Aa}	14^{Aa}	14^{Aa}	14^{Aa}
7	14^{Aa}	13^{Bb}	13^{Bb}	13^{Bb}	13^{Bb}
14	12^{Ba}	11^{Cb}	11^{Cb}	11^{Cb}	11^{Cb}
21	12^{Ba}	11^{Cb}	11^{Cb}	11^{Db}	11^{Cb}
Body and texture (35)					
Fresh	34^{Ab}	34^{Ab}	35^{Aa}	33^{Ac}	32^{Ad}
7	33^{Ba}	31^{Bc}	33^{Ba}	32^{Bb}	31^{Bc}
14	31^{Cb}	30^{Cc}	32^{Ca}	30^{Cc}	30^{Cc}
21	30^{Da}	29^{Db}	30^{Da}	29^{Db}	27^{Dc}
Flavor (50)					
Fresh	48^{Ab}	49^{Aa}	49^{Aa}	49^{Aa}	49^{Aa}
7	47^{Bc}	49^{Aa}	49^{Aa}	49^{Aa}	48^{Bb}
14	46^{Cc}	48^{Bb}	49^{Aa}	48^{Bb}	46^{Cc}
21	45^{Db}	46^{Ca}	46^{Ba}	45^{Cb}	41^{Dc}
Over all acceptability (100)					
Fresh	96^{Ac}	97^{Ab}	98^{Aa}	96^{Ac}	95^{Ad}
7	94^{Bb}	93^{Bc}	95^{Ba}	94^{Bb}	92^{Bd}
14	89^{Cb}	89^{Cb}	92^{Ca}	89^{Cb}	87^{Cc}
21	87^{Da}	86^{Db}	87^{Da}	85^{Dc}	79^{Dd}

$^{A-D)}$ Different uppercase superscripts represent significant differences in the same column ($P < 0.05$)

$^{(a-e)}$ Different lowercase superscripts represent significant differences in the same row ($P < 0.05$)

*As written under Table 1.

4. CONCLUSION

In conclusion, White soft cheese can be produced from pasteurized cow milk with a good flavour and texture using probiotic bacteria starters. Also, it can be stored for 21 days with enough probiotic bacteria (7-9.52) log cfu/g. Adding probiotic bacteria like Bifidobacteria breve, Lactobacillus plantarum, and a mix of Bifidobacteria breve culture and Lactobacillus plantarum culture to white soft cheese enhanced the nutritional value and antioxidant properties of white soft cheese during the storage period (21 days). The mix of Bifidobacteria breve culture and Lactobacillus plantarum culture treatment was the highest antioxidant value during the storage period (21 days). So it may be recommended to use these strains to produce white soft cheese.

5. References

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