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USE OF POSTBIOTIC OF *LACTOBACILLUS PLANTARUM* IN PROLONGING THE SHELF LIFE OF SOFT CHEESE

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ABSTRACT

This study was included the manufacture of 6 treatments of soft cheese by adding the probiotic of *Lactobacillus Plantarum* and its metabolic products. as well as, its dead cells after killing them by heat until they curd in121°for15minutes. Two concentrations of 5 and 10% have been used for each addition, and comparing these treatments with a control. The results showed that an increase in bacterial numbers in the control treatment and in the number of coliform bacteria, with the appearance of yeasts and molds as the storage period progressed toward 24 days. However, it was noted that in the treatment of cheese containing the probiotic *Lactobacillus Plantarum* and its metabolites, the bacterial numbers were lower and more stable, such that no clear development was observed in their numbers during a period of 24 d when stored at 7±1ºC. It was also recorded that these treatments were free of cold bacteria, coli bacteria, yeasts, and molds. Thus, these results were reflected in the chemical properties of these treatments in terms of pH, total acidity, dissolved nitrogen, and the degree of fatty decomposition. Their values were lower in the fortified treatments compared to the control treatment, which showed a clear deterioration after 10 days of preservation at 7±1 ºC.

Key Word: Probiotic, *L. Plantarum*, Postbiotic, soft cheese, shelf life.

استعمال Postbiotic لبكتريا *Lactobacillus Plantarum* في إطالة العمر الخزني للجبن الطري

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الخلاصة

تضمنت الدراسة تصنيع 6 معاملات من الجبن الطري باضافة بكتريا المعزز الحيوي *Lactobacillus Plantarum* ونواتجها الايضية وايضا الخلايا الميتة منها بعد قتلها بالحرارة بدرجة 121 م لمدة 15 دقيقة الى الخثرة وبالتركيزين 5 و 10% لكل اضافة، ومقارنة هذه المعاملات مع معاملة جبن السيطرة، اظهرت النتائج زيادة الاعداد البكتيرية في معاملة السيطرة واعداد بكتريا القولون مع ظهور للخمائر والاعفان بتقدم مدة الحفظ باتجاه 24 يوم، في حين لوحظ ان معاملة الجبن الحاوية على المعزز الحيوي لبكتريا *Lactobacillus Plantarum* ونواتجها الايضية كانت فيها الاعداد البكتيرية اقل واكثر استقرارا بحيث لم يلاحظ تطور واضح في اعدادها خلال مدة 24 يوم عند حفظها في درجة 7± 1 م ، ايضا لوحظ خلو هذه المعاملات من البكتريا المحبة للبرودة وبكتريا القولون والخمائر والاعفان، وبالتالي انعكست هذه النتائج على الصفات الكيميائية لهذه المعاملات من حيث الاس الهيدروجيني الحموضة الكلية و النتروجين الذائب

ودرجة التحلل الدهني اذا كانت قيمها اقل في المعاملات المدعمة مقارنة بمعاملة السيطرة والتي اظهرت تدهورا واضحا فيها بعد مرور 10 ايام من حفظها في درجة 7± 1 مْ .

الكلمات المفتاحية: المعزز الحيوي، بكتريا *L. Plantarum*، *النواتج الثانوية*، الجبن الطري، مدة الصلاحية.

INTRODUCTION

Lactobacillus plantarum is a type of lactic acid bacteria and commonly found in fermented foods and also present in the digestive system of humans. It has been used as a probiotic during previous years. It is a facultative anaerobic bacterium that ferments sugars and turns them into lactic acid in the absence of oxygen. It is widely used in fermenting foods such as dairy (fermented milk and cheese), as well as vegetables like pickles olives and also in fermenting meat and fish **(Azat *et al.*, 2006; Mayo *et al.*, 2010**; **Milani *et al.*, 2017**). Also, fermented pentose sugar is produced lactic and acetic acid in the presence of phosphoketolase **Todorov *et al.*, (2010)** The characteristics of *L. Plantarum* are that they are gram-positive, non-spore-forming, catalase-negative, acid-tolerant, facultatively anaerobic, and non-pathogenic from a biochemical perspective. These bacteria also produce large products during the fermentation process, such as acetic acid, carbon dioxide, and formic acid. They also have the ability to grow in a range of temperatures and pH levels (**Doyle & Meng, 2006; Halder *et al.*, 2017**). Some types of lactic acid bacteria have the ability to produce bacteriocins in high quantities **(Hussein & Luti, 2023).** Postbiotics are defined as soluble products produced by microorganisms during growth and fermentation in the intestinal flora. They are rich in active products of high and low molecular weight. These products play a major role in growth, reproduction, regulating self-growth, and supporting the growth of beneficial microorganisms (**Netzker *et al.*, 2015)**.

Khani *et al.*, (2022) defined postbiotics as soluble substances secreted or released by bacteria during decomposition (enzymes, peptides, teichoic acids, muropeptides derived from peptidoglycans, polysaccharides, cell surface proteins and organic acids). Also, **Khani *et al.*, (2022)**) have reported that it as immune boosters that help reduce inflammation caused by pathogens and support the endurance of intestinal epithelial cells. It produces many vital substances, including teichoic acid, indole, polysaccharide lipid, muramyl dipeptide and Lactospin**. Nataraj *et al.*, (2020)** have been found that Postbiotics are a complex mixture of metabolic products secreted by probiotics such as enzymes, secreted proteins, short-chain fatty acids, vitamins, secreted prebiotics, amino acids, peptides, organic acids. They may be referred to as inactivated microbial cells from probiotics (intact or disrupted containing cellular components such as peptidoglycans, teichoic acids and proteins.) or crude cell extracts (with a complex chemical composition). probiotics is one of the most important nutritionally and healthy synergistic functional foods **(Mahdi, 2017).**

Lactobacillus derived chemicals act as a substitute for live bacteria (probiotics) in foods and the host body when not enough probiotics are available **(Williams et al., 2003).** A probiotic may produce a metabolic byproduct that affects the host's organic capacity (organic capacity means the body's biological capabilities such as absorption, digestion, and overall gut health) **(Ooi *et al.*, 2021**). Some strains of probiotics are effective in inhibiting aerobic and anaerobic pathogenic bacteria **(Alziadi *et al.*, 2020)**

Furthermore, postbiotics are important because they stimulate the growth and activity of Lactobacillus and Bifidobacterium species **(Dinu *et al.*, 2022)**. It has been found that postbiotics help reduce blood sugar and improve insulin function in obese people **(Rad *et al.*, 2022**; **Alfahdawy, 2022)**. They inhibit the growth of pathogens, maintain the integrity of the intestinal mucosa, and enhance the balance of the host's microbial content all of which help maintain postbiotics, which have therapeutic advantages **(Deeth *et al.*, 1976)**.

The effectiveness of postbiotics depends on the nature of the target condition by influencing cellular and molecular processes such as modulation of the immune and nervous systems. Probiotics are expected to be more stable than the live bacteria from which they are produced **(Venema, 2013).** Probiotic strains can be isolated from different sources, like gut microbiota, or from dairy products **(Rasheed *et al.*, 2020**). Bacilicin and chlorotitin are two types of antimicrobial substances produced by Bacillus sp. strain CS93 which is water soluble and active over a wide pH range. **Phister *et al.*, (2004)** have been found that a variety of food products may benefit from the use of metabolites, and furthermore. It was suggested that the use of some phytase producing lactic acid bacteria is a good alternative for the production of low phytate whole wheat bread **(Palacios *et al.* 2008)**. Probiotic is added to foods to give health benefits to the body and prolong the shelf life of those foods, especially dairy products **(Kalalou *et al.*, 2010**).

MATERIALS AND METHOD

Activation of *L. plantarum* probiotics

The capsule of the commercially prepared *L plantarum* probiotic from Nature's Bounty Swanson (USA) was emptied into 9 ml of liquid MRs culture medium. It was prepared according to company's recommendations and incubated at a temperature of 37°C for 24 hours. This process was repeated three times. Then, all the steps mentioned are repeated using the prepared sorted milk, adding the starter at a rate of 10%, incubating it at the same temperature until coagulation, and then repeating the activation process three times to achieve the desired work **(Robinson, 1990).**

Calculating the total number of *L. plantarum* probiotic: After the incubation process, the total number of probiotics was calculated according to the method of **(Mathialagan *et al.*, 2018)**.

Preparation of *L. plantarum* probiotic treatments

Preparation of postbiotics secondary metabolites: After the activated three times, the medium (sorted milk+ *L. plantarum* probiotic) was emptied into centrifuge tubes and a refrigerated centrifuge was performed (8000 rpm) for 15 mins. To obtain the filtrate containing the postbiotics, it was separate it by filtration using a Buechner funnel. The filtrate was then taken after the end of the process and sterilized by passing it through a 0.45 Millipore, after which the filtrate was placed in sterile bottles and stored at a temperature of 4°C until use.

Preparation of dead cells: The dead cells of the probiotic *L. plantarum* were prepared by taking part of the cells of this probiotic (which had been prepared previously) and placing them in tightly sealed bottles, and exposing them to a temperature of 121°C for 15 mins in order to kill them.

Manufacture of soft cheese transactions:

Control treatment (T4): A soft white cheese treatment fortified with secondary metabolites of the probiotic *L. plantarum* was made by pasteurizing the milk to a temperature of 63°C/30 minutes and then cooling it to 34°C to add *mucar miehei* (*Microbial* renin enzyme) according to the instructions of the supplying company. The milk was left until cheese was obtained. Then, the manufacturing steps were completed including cutting, layering, and stirring, then draining the whey, salting with 2% sodium chloride salt, filling the curds in the molds, and keeping them in the refrigerator until the next day to extract the cheese (**Al-mosowy *et al*., 202**1).

White cheese treatment fortified with secondary metabolites of the probiotic *L. plantarum* (T3): This treatment was made by following the steps mentioned when preparing the control treatment. The secondary metabolites of *L. plantarum* added to the cheese curd after its preparation was completed at two concentrations of 5 and 10% by weight curd and mix well with it.

Treatment of soft white cheese fortified with live probiotic cells (T1): This treatment was made by adding the pre-prepared probiotic *L. plantarum* to the cheese curds after their preparation had been completed at two concentrations of 5 and 10% of the curd weight, and mixed well.

Preparation of the soft white cheese treatment fortified with dead cells (T2): In this treatment, dead cells from the probiotic *lactobacillus plantarum* were prepared as previously mentioned. They were added to the cheese curds after their preparation had been completed at two concentrations of 5 and 10% of the weight of the curds, and mixed well.

Then, the manufacturing steps were completed in succession and the cheese parameters were stored in the refrigerator (at a temperature of 7°C ±1) to conduct the required tests on them, which included **(Hool *et al*., 2004)**: estimation of the pH. The acidity correction **(A.O.A.C, 2008**), and dissolved nitrogen **(Joslyn, 1970**), and lipid pH (ADV) by the (BDI) method mentioned by **(Deeth, & Fitz- Gerald, 1976**), and to estimate live populations of the probiotic *lactobacillus Plantarum*. The MRS-Agar medium was used according to **Al-Aqidi (2019)** using the pouring plate method. To calculate the numbers of coli bacteria in the cheese samples, the method of **Kayagil (2006)** was followed, and to calculate the numbers of yeasts and molds in the cheese samples **(Kayagil, 2006)**, and the total numbers were estimated. For microorganisms in cheese samples, it was followed the method of **Kayagil (2006)**.

Statistical Analysis:

The Statistical Analysis System SAS program was used **(SAS, 2018)** to detect the effect of difference factors in study parameters. Least significant difference –LSD test (Analysis of Variation-ANOVA) was used to significant compare between means. in this study.

RESULTS AND DISCUSSION

The live numbers of *L. Plantarum* that used in the manufacture of soft cheese were estimated at two concentrations of 5 and 10%. It was found that using sorted milk with 12% total solids to activate the probiotic bacteria *L. Plantarum* with an inoculum rate of 10% and incubating at a temperature of 37°C and repeating the activation three times helped in

obtaining higher live numbers, reaching a maximum in the third activation when it was 35 $x10^{10}$ cfu/g in the 5% vaccine, while the numbers were 42 x 10^{10} cfu/g when the vaccine concentration was 10%. The importance of the third activation is to help in imprinting the probiotic bacteria, as well as activating new metabolic pathways for them, depending on the type of sugar available and using the fortified sorting medium **(Duan *et al.*,2019).**These numbers of probiotic bacteria are in line with **(Gao *et al.*, 2010)** that products containing probiotics must contain live numbers of no less than 107 cfu/g or ml in order to achieve health properties, because numbers Large ones can die in the stomach and small intestine before reaching the colon (**Borody & Campbell , 2011).**

Chemical properties of soft cheese:

pH and percentage of normalized acidity:

The results showed that the pH values and percentage of normalized acidity for soft cheese treatments with the addition of live bacteria for the probiotic *L. Plantarum* (T1), the cheese treatment with the addition of dead cells for the probiotic *L. Plantarum* (T2), and the cheese treatment with the addition of products. Also, biometabolites of the probiotic *L. Plantarum* at concentrations of 5 and 10% per treatment (T3) was studied (Table 1). In addition, the control treatment (T4) that stored for 24 days at refrigerator temperature (7±1°C). It is noted that the pH values for all cheese treatments at the age of 1 day of manufacturing were 6.2 - 6.3. It was clear that the difference in the added concentration of the probiotic, secondary metabolites, and dead cells had no effect on the pH values at this age. As the preservation period progressed, at the ages of 3, 6, 9, and 12 days, there was no change in the pH values for all treatments and at both concentrations. However, a decrease in pH values was observed after 15 and 24 days of preservation for some treatments, as it decreased from 6 to 5.9 at 24 days of age in the T1 treatment to which the probiotic bacteria *L. Plantarum* was added at a concentration of 5%, while it decreased to 5.8 and 5.9 when adding.

The concentrations of 5 and 10% of dead cells of *L. Plantarum* at the end of the preservation period, and the greatest decrease was in the cheese of the control treatment, in which it decreased to 5.8, 5.4, and 5 at the ages of 6, 9, and 12 days. Compared to these results, the results found that the cheese treatment with secondary metabolites of these bacteria added at concentrations of 5 and 10%, the pH maintained its value during the period of 24 days and no significant change was observed. The results of the normalized acidity of the different soft cheese treatments indicated that their acidity ranged between 0.12 and 0.15% at the age of 1 day. As the duration of refrigerated storage progressed, a non-significant increase in the acidity percentage appeared in some cheese treatments, which corresponded with the decrease in the pH values of these treatments. The acidity percentage was 0.16% in treatment (T1).

At the same time, the results showed that in the treatment (T1) with the concentration of 10% and the treatment (T3) with the concentrations of 5 and 10% that the percentage of leachate acidity remained constant and no change occurred in it until the end of the refrigerated preservation period of the cheese, while there was an increase in the percentage of leachate acidity in the treatment T4 control. It increased from 0.12% on the first day to reach 0.30% on day 12, as the cheese was then unfitted for consumption. A clear decrease in the pH value and an increase in the acidity level occurred for the T4 treatment. It may be attributed to the growth

of microorganisms contaminated by this treatment. The results regarding the acidity of soft cheeses are agreed with **Yerlikaya and Ozer (2014)**.

Table (1): Effect of adding live bacteria, dead cells, and vital metabolites of the probiotic *L. Plantarum* on pH and acidity (%) of soft cheese for the period of 24 d at 7±1°C.

L. Plantarum		PH							LSD	Tactic acidity (%)							LSD
		shelf period (day)								shelf time (day)							
Treatment	Con. (%)	1	3	6	9	12	15	24		1	3	6	9	12	15	24	
T1	5	6.2	6.2	6.1	6.2	6.0	6.0	5.9	0.59 NS	0.15	0.15	0.15	0.15	0.15	0.15	0.16	0.04 NS
	10	6.3	6.2	6.1	6.1	6.0	6.0	6.0	0.44 NS	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.02 NS
T2	5	6.2	6.2	6.1	6.1	6.0	5.8	5.7	0.53 NS	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.04 NS
	10	6.2	6.1	6.0	6.1	5.9	5.9	5.8	0.49 NS	0.15	0.15	0.15	0.15	0.17	0.17	0.17	0.03 NS
T3	5	6.2	6.2	6.1	6.2	6.1	6.1	6.0	0.41 NS	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.02 NS
	10	6.3	6.3	6.2	6.2	6.1	6.1	6.1	0.38 NS	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.02 NS
T4	0	6.2	6.1	5.4	5.8	5.0	-	-	0.61 *	0.12	0.17	0.21	0.27	0.30	-	-	0.052 *
LSD		0.37 NS	0.31 NS	0.58 *	0.44 NS	0.71 *	0.66 *	0.42 NS	---	0.04 NS	0.04 NS	0.052 *	0.067 *	0.072 *	0.04 NS	0.04 NS	---

** (P≤0.05), NS: Non-Significant.

Probiotic bacteria including *L. Plantarum* converts the lactose sugar found in milk or its products into lactic acid. This conversion leads to a decrease in pH and an increase in leachate acidity, but cold storage of soft cheese treatments to which probiotic bacteria are added has helped in reducing the activity and growth of probiotic bacteria and their metabolism of lactose. When using vital metabolites with soft cheese, as was noted from the results, that there was no development in its acidity, and it remained at the same level throughout the preservation period of 24 days. **Kalalou *et al.* (2010)** indicated that Postbiotic contains many factors produced by probiotic bacteria, such as bacteriocins and hydrogen peroxide. Low molecular weight metabolic compounds, such as diacetyl and carbon dioxide, in addition to enzymes, contribute to inhibiting many types of contaminating bacteria, which may contribute to lowering the pH and developing acidity in dairy products.

Protein and fat degradation in soft cheese

The results of this study have been showed that there are differences in the percentage of soluble protein %SN between the different soft cheese treatments under study. The %SN in the control cheese treatment (T4) was 1.18% at the age of 1 d (Table, 2). However, it was 0.88% in treatment T1, and 1.48% and 1.68% in treatments T2 and T3, respectively, and when %SN was estimated after 24 d of refrigerated storage at a temperature of 7±1°C, a decrease in the concentration of this soluble protein was seen on this day for treatment T1, and no a change in its percentage in treatment T3 compared to what it was on the first day, as the percentage reached 0.68% and 1.48%, respectively. In contrast, it was observed that the concentration of soluble protein was higher on day 24 for treatments T2 and T4 than it was on the first day, reaching 1.68% and 2.08% in those two treatments, respectively. The increase in the

percentage of soluble protein in treatments T2 and T4 is due to the activity of a group of protease and peptidase enzymes (**Duan *et al*., 2019**).

The presence of these enzymes at high levels usually helps promote secondary protein hydrolysis and amino acid formation, leading to improved sensory qualities in cheese **(Zhang *et al.*, 2017**). But, the reason for the lack of an increase in the percentage of soluble protein in treatments T1 and T3 may be due to the inhibitory effect of probiotic bacteria on many types of proteolytic bacteria. **Price & Lee, (1999)** have been indicated that the metabolites of probiotic bacteria have a negative effect on several types of cold-loving, proteolytic bacteria.

Table (2): Effect of adding live bacteria, dead cells, and vital metabolites of the probiotic *L. Plantarum* on soluble protein expressed in proteolytic and ADV expressed in lipolysis of soft cheese for the period of 24 d at 7±1°C.

Treatment	shelf period (day)	Soluble protein (%)	ADV value (cfu/100g fat)	LSD
T1	1	0.88	1.09	0.281 NS
	24	0.68	1.09	0.386 *
T2	1	1.48	0.87	0.417 *
	24	1.68	0.87	0.566 *
T3	1	1.68	1.09	0.519 *
	24	1.68	0.65	0.722 *
T4	1	1.18	1.09	0.224 NS
	7	2.08	2.18	0.207 NS
LSD		0.605 *	0.594 *	---
** (P≤0.05), NS: Non-Significant.				

The estimating the amount of fatty decomposition of soft cheese during the period of refrigerated storage at a temperature of 7±1°C, which was 24 days, and expressed as the degree of fatty decomposition ADV, the results in parameters T1 and T2 indicated a stability in the percentage of fatty decomposition, which amounted to (1.09 and 0.87) cfu /100 gm fat. However, a decrease in the ADV value was observed in the T3 treatment from 1.09 to 0.65 cfu /100 gm fat, in contrast, the T4 treatment showed an increase in the ADV value from 1.09 to 2.18 cfu/100 gm fat. These results are in line with (**Doosh & Abdul-Rahman (2014**) that found that the ADV value of the cheese of the control treatment for soft cheese ranged between (0.88 - 3.35) cfu / 100 gm fact during a period of 15 days of refrigerated storage. The results of the T1 and T2 treatments indicate that there is no effect of L. Plantarum on the fat content of processed cheese.

These results were consistent with the results of a study on the production of soft cheese using L. plantarum and Streptococcus thermophilus bacteria. The effect of different concentrations of Plantarum bacteria on the content of processed cheese was not explicitly mentioned (**Hosiana, 2023**). Another study in the manufacture of cream cheese found that the use of mixed starter culture resulted in a higher fat content compared to the individual starter culture. However, the study by (**Tologana *et al.*, 2023**). no mentioned that the effect of L. plantarum on lipid content.

Microbial tests for soft cheese

The effect of shelf time on the number of microorganisms was studied, which included the total number of bacteria, cold-loving bacteria, coli bacteria, yeasts, and molds in different treatments of soft cheese. Table (3) shows that the total number of *L. plantarum* in treatment T1 when added at concentrations of 5 and 10% ranged between (30×10^{10} - 24×10^{9}) cfu/g and over the course of 24 days, meaning that the numbers of these bacteria was within the required limits, namely, not less than 107 cfu/g or ml. These results are consistent with reported by **González-Olivares *et al.***, (**2014**) that the numbers of the probiotic *L. rhamnosus* GG applied to the cheese begin to gradually diminish when stored at a refrigerator temperature of 4-8°C, which indicates that this microorganism begins to lose its vitality. Its numbers decrease, even slightly, when stored in refrigeration. In contrast, the total bacterial numbers were calculated, which ranged between (18×10^{4} -30×10^{4}) cfu/g on the first day for treatments T2, T3, and T4. As the storage period progressed, it was noted that the numbers of bacteria varied between the treatments. In the treatment T3, a decrease in the total numbers until the end of the storage period was found.

However, in treatment T2, the numbers increased at a logarithmic rate, but after two weeks of storage. In contrast, the numbers of bacteria in treatment T4 increased significantly as the storage period progressed, until they became rejected and uncountable at 12 days of age. The effect of low temperature on bacterial growth is through reduced affinity for nutrients, which limits growth at low temperatures and microorganisms become unable to utilize necessary compounds. This impact may have profound effects, exacerbating near-famine conditions in many natural environments. Low temperatures usually inhibit or stop microbial growth and spread, but often do not kill bacteria **(Fuchs *et al*., 2013)**. The results also indicated that there was no growth of cold-loving bacteria for the T1 treatment, while their numbers ranged between (13-20) x 10^{3} cfu/g in all treatments at the age of 1 day. The storage period progressed, a gradual decrease in the numbers of bacteria was observed until day 24 for treatment T3. In contrast, their numbers increased in treatment T4. As the storage period progressed, the numbers of bacteria became uncountable in treatment T4. It was noted from the results that the T1 treatment was free of the growth of cold-loving bacteria, and it was also noted that their numbers decreased in the treatment containing Postbiotic.

The reason was to the presence of competition with the *L. Plantarum* present in cheese and to its physiological compatibility with cheese in addition to its ability to produce compounds with antibacterial properties with the exception of treatment T4, which recorded an increase in the numbers of cold-loving bacteria. This may be due to the fact that it does not contain *L. Plantarum* (10). It was noted that there was no growth of coli bacteria over the length of storage period in the different treatments of soft cheese, as well as no growth of yeasts and molds, with the exception of treatment T4. The appearance of these organisms was observed after 12 days. This is due to the soft cheese containing a high level of moisture, ranging between 55% and 80% (**Williams & Phillips**, **2003**), which helps the growth of yeasts and molds, in addition to the absence of *L. plantarum* in the T4 control treatment.

(Alabadi, 2014) has been reported that the presence of *L. Plantarum* helped prevent the appearance of coli bacteria, yeasts, and bacterium in soft cheese treatments containing *L. Plantarum*. (**Abdulkarem & Hassan, 2022)** have been observed a significant decrease in the number of microorganisms in soft cheese to which different concentrations (5, 10, and 15) ml

of crude bacteriocin of *Lactobacillus bulgaricus*/ kg curd were added compared to the control treatment when the cheese was stored for 21 days.

Table (3): Changes in the microbial numbers of soft cheese to which live bacteria, dead cells, and vital metabolites of the probiotic *L. Plantarum* were added at different concentrations during its preservation period of 24 d at a temperature of 7±1°C.

Treatment	Con.	Test cfu/gm	shelf period (day)							LSD
			1	3	6	9	12	15	24	
T1	5%	Total No. of L. Plantarum	29×10^{9}	29×10^{9}	27×10^{9}	28×10^{9}	28×10^{9}	25×10^{9}	24×10^{8}	13.08 *
		Cold bacteria	-	-	-	-	-	-	-	-
		Yeasts and molds	-	-	-	-	-	-	-	-
		coli bacteria	-	-	-	-	-	-	-	-
	10%	Total No. of L. Plantarum	30×10^{10}	29×10^{10}	27×10^{10}	27×10^{10}	26×10^{10}	25×10^{10}	23×10^{9}	17.54 *
		Cold bacteria	-	-	-	-	-	-	-	-
		Yeasts and molds	-	-	-	-	-	-	-	-
		coli bacteria	-	-	-	-	-	-	-	-
T2	5%	Total No. of L. Plantarum	21×10^{4}	24×10^{4}	31×10^{4}	33×10^{4}	22×10^{5}	30×10^{5}	32×10^{5}	11.63 *
		Cold bacteria	15×10^{3}	15×10^{3}	14×10^{3}	23×10^{3}	31×10^{4}	32×10^{4}	38×10^{4}	16.55 *
		Yeasts and molds	-	-	-	-	-	-	-	-
		coli bacteria	-	-	-	-	-	-	-	-
	10%	Total No. of L. Plantarum	27×10^{4}	28×10^{4}	34×10^{4}	36×10^{4}	43×10^{4}	21×10^{5}	23×10^{5}	9.74 *
		Cold bacteria	13×10^{3}	15×10^{3}	15×10^{3}	16×10^{3}	16×10^{4}	17×10^{3}	15×10^{4}	8.37 *
		Yeasts and molds	-	-	-	-	-	-	-	-
		coli bacteria	-	-	-	-	-	-	-	-
T3	5%	Total No. of L. Plantarum	24×10^{4}	22×10^{3}	23×10^{2}	22×10^{2}	21×10^{2}	20×10^{2}	17×10^{2}	13.78 *
		Cold bacteria	18×10^{3}	17×10^{2}	17×10^{2}	17×10^{2}	16×10^{2}	15×10^{2}	13×10^{2}	8.43 *
		Yeasts and molds	-	-	-	-	-	-	-	-
		coli bacteria	-	-	-	-	-	-	-	-
	10%	Total No. of L. Plantarum	18×10^{4}	15×10^{3}	15×10^{3}	14×10^{3}	13×10^{2}	13×10^{2}	12×10^{2}	11.05 *
		Cold bacteria	17×10^{3}	14×10^{3}	16×10^{3}	12×10^{3}	10×10^{3}	12×10^{3}	10×10^{3}	5.96 *
		Yeasts and molds	-	-	-	-	-	-	-	-
		coli bacteria	-	-	-	-	-	-	-	-
T4		Total No. of L. Plantarum	30×10^{4}	34×10^{5}	36×10^{6}	35×10^{8}	Not calculate	Not calculate	Not calculate	14.59 *
		Cold bacteria	20×10^{3}	24×10^{4}	20×10^{5}	24×10^{7}	Not calculate	Not calculate	Not calculate	9.42 *
		Yeasts and molds	-	-	-	-	9×10^{5}	8×10^{5}	11×10^{5}	7.38 *

		coli bacteria	-	-	-	-	-	-	-	-
LSD			9.82 *	14.57 *	11.94 *	14.88 *	8.42 *	8.05 *	10.91 *	-
** (P≤0.05).										

CONCLSION

The results showed the ability of the remaining probiotics of *L. Plantarum* to improve the storage properties of soft cheese by maintaining the non-development of the number of microorganisms in it throughout the storage period at conditions at a temperature of 7°C. It was reflected in the improvement of the chemical properties of the cheese, represented by pH, total acidity, and the amount of protein and fat hydrolysis of the cheese compared to the control treatment. Therefore, Postbiotic can be used as a good alternative to the bacteria that produce it.

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