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IMPROVING THE HEALTH BENEFITS AND QUALITY OF LABNEH USING PROBIOTIC BACTERIA

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ABSTRACT: The effects of adding different strains from probiotic bacteria on the properties of Labneh were studied. Five Labneh treatments were made. Control Labneh treatment (C) was made by inoculating the milk with 0.03% of freeze dried normal youghurt starter. Another three treatments were made by inoculating milk with 0.03% freeze dried normal youghurt starter plus 1.0% from each of Lactobacillus acidophilus (T1), Bifidobacterium bifidum (T2) and Lactobacillus plantarum (T3), while the fifth treatment was made by inoculating the milk with 0.03% freeze dried normal youghurt starter plus 0.33% from each of the previous three stains as a mixture. The obtained results revealed that the type of probiotic bacteria added during the manufacture of Labneh affected significantly (p≤0.05) the chemical composition, microbiological, rheological and organoleptic properties of Labneh. Treatment (T4) that made with a mixture from probiotic bacteria contained the highest acidity, total solids, protein, fat, acetaldehyde and diacetyl followed by treatments T1 and T3 those made by adding L. acidophillus and L. plantarum respectively and then T2 and C treatments. Also treatment (T4) exhibited the highest values for Hardness, Adhesiveness, Cohesiveness, Springiness, Gumminess and Chewiness, which means improving the texture parameter, followed by Labneh treatments T1 and T2 and then T3 followed by C. Incorporating of probiotic bacteria improved the organoleptic properties and gained higher scores than control Labneh treatments. Although all Labneh treatments were accepted by the panelists, Labneh treatment (T3) that was made by adding L.plantarum gained the highest scores of organoleptic properties and was the most acceptable Labneh treatment T1 and T4 , then T2, followed by treatments. Titratable acidity, total solids, protein, fat and ash contents and values of Hardness, Adhesiveness, Cohesiveness, Springiness, Gumminess and Chewiness increased during storage period, while pH values and lactose content decreased. Diacetyl and acetaldehyde content increased up to the seventh day of storage period then decreased as storage period proceeded. The counts of each probiotic bacteria even at the end of storage period was higher than the number should be present to achieve their health benefits, therefore Labneh could be a promising vehicle to deliver the probiotic bacteria to the consumers.

Key words: Labneh, probiotic bacteria, texture parameters, organoleptic properties.

INTRODUCTION

Labneh or strained/concentrated yogurt is a traditional fermented milk product. It is a popular food in various parts of the world, especially in the Middle East (Syria, Lebanon, Jordan and Palestine). In recent years, the Labneh demand increased in Egypt. Labneh is a white to creamy paste that has a smooth texture, with a taste crossing between sour cream and cottage cheese and a properties sharp flavor that is largely modulated by diacetyl produced during

fermentation (Tamime and Robinso, 1999). The total solids (TS) content is typically 23 – 25 % and the product have a cream/white colour, a soft and smooth body, a good spread ability with little syneresis and a flavour that is clean and a little acidic (Rasic 1987).

Probiotics are defined as living microorganisms, are non-pathogenic which, when ingested in sufficient amounts, beneficially influence the health of the host by improving the composition of intestinal microflora. In addition to improving gut health, probiotics may play a beneficial role in several medical conditions, including lactose intolerance, cancer, allergies, hepatic disease, urinary tract infections, assimilation of cholesterol (Ejtahed et al., 2011). Such as lactic acid bacteria and yeasts used in fermentation procedures) which can be used in foods in order to improve the normal flora of host intestine (FAO/WHO, 2001).

The objective of this study were to evaluate the effect of adding L.acidophilus, Bifidobacterium bifidum and L.plantarum individually or a mixture from these bacteria on the physicochemical ,chemical, microbiological, rheological and organoleptic properties of Labneh and monitor the survival of probiotic bacteria and changes of Labneh qualities during the storage period.

MATERIALS AND METHODS

Bacterial strains:

Yoghurt starter Freeze dried conventional yoghurt starter culture (FD-DVS YC-X11-Yo-Flex) containing Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgaricus (1:1) was obtained from Chr Hansen,s Laboratories, Copenhagen, Denmark. The starter was directly added at ratio of 0.03% to the milk as recomended by the manufacturer, probiotic strains active Bifidobacterium bifidum (DSM 20082), was obtained from Cairo Mircen, Ain Shams University, Egypt. Lactobacillus plantarum (ATCC 14917), and Lactobacillus acidophilus (ATCC 20225) were obtained from Agricultural Research Center, Giza, Egypt. Lactobacillus plantarum and Lactobacillus acidophilus were activated individually by three successive transfers in sterile 10% reconstituted non-fat dry milk. Bifidobacterium bifidum was activated by three successive transfers in modified MRS broth medium (Ventling and Mistry, 1993), followed by three successive transfers in sterile 10% reconstituted non-fat dry milk and inoculated at 37°C under anaerobic condition.

Manufacture of Labneh:

Labneh was manufactured according to Robinson and Tamime (1994). Fresh buffalo's milk (5.5% fat) was heated at 90°C for 10 min, cooled to 42°C and then inoculated with 0.03% of the yoghurt starter culture (S. thermophilus + L. bulgaricus). Then divided in to five treatments, one of them was made without probiotic bacteria and served as control (C); while the other four treatments were made by adding 1.0% from each of Lactobacillus plantarum, Bifidobacterium bifidum, Lactobacillus acidophilus and a mixture the previous bacteria (% 0.33 : 0.33 : 0.33) individually to the milk before incubating. Milk was incubated at 42°C until complete coagulation then the curd was poured into cheese cloth bags, which were hung in the refrigerator at 5 + 1°C for 18 h, to allow drainage of the whey. The fresh labneh was packaged into small plastic containers and stored for 21 days at 5 + 1°C. Samples were taken from each Labneh treatment when fresh and at 7, 14, 21 days for chemical microbiological, rheological analysis and sensory

evaluation. The whole experiment was triplicated.

Microbiological analysis:

Total bacterial counts were enumerated on nutrient agar medium according to Difco (1971). Lactobacillus plantarum counts were determined according to Bujalance et al. (2006), while Lactobacillus acidophilus counts were determined using MRS agar medium according to Dave and Shah (1996). Modified MRS agar medium was used to enumerate bifidobacteria (Ventling and Mistry, 1993) and NPNL solution was added to the medium before pouring plates (Samona and Robinson, 1991). Moulds and Yeasts were enumerated on acidified potato dextrose agar medium (Difco, 1953). Psychrotrophic bacterial counts were determined according to Cempírková (2002).

Physiochemical analysis:

The method of Lawrence (1968) was used to determined lactose. Titratable acidity, pH value and fat content were determined according to Ling (1963), while total solids, total protein and ash contents were determined according to A.O.A.C. (2012). Acetaldehyde and Diacetyl contents were determined according to the method described by Less and Jago(1969).

Rheological analysis:

Texture parameters were determined as describe by Bourne (1978) .

Sensory evaluation:

The labneh samples were evaluated by ten panelists of staff members of Agricultural Research Centre using the scheme of Salem et al. (2007), for flavour (50 points), Body & texture (40 points), and appearance (10 points) on the 0, 7, 14 and 21 days of cold storage at 6 + 1°C.

Statistical analysis:

Data were analyzed using 2 × 3 factorial design. Newman-keels. Test was used to make the multiple comparisons (Steel and Torrie, 1980) using Costat Program. Significant were determined at $p \leq 0.05$.

RESULTS AND DISCUSSION

Chemical properties

The obtained results indicated that titratable acidity of all labneh treatments increased significantly ($p \leq 0.05$) as storage period proceeded (Tables 1, 7). This increase of titratable acidity might be due to the retaining of bacteria in labneh and increase their counts, which subsequently ferment more lactose to lactic acid. These results are in agreement with those reported by Abdalla and Abdel Nabi (2010), and Thabet et al. (2014). On the other hand, there were significant ($p \leq 0.05$) differences among labneh treatments (Tables 1, 7), which means that the type of starter used in making of labneh affected significantly ($p \leq 0.05$) the titratable acidity of the resultant Labneh (Tables 1, 7). On the other hand, pH values as affected by probiotic bacteria and storage period followed on opposite trends of those of titratable acidity (Tables 1, 7), total protein and fat contents followed almost similar trends. There were significant ($p \leq 0.05$) differences among Labneh treatments (Tables 2, 7), which means that the type of starter used in the manufacture of Labneh had significant ($p \leq 0.05$) effect on the total solids, total protein and fat contents of the resultant Labneh (Tables 2,7) (Shaker et al., 2002 and Abd El-Salam et al., 2011and Ismail et al. (2017). These results might be due to increasing the acidity helps to expel the whey from the curd and consequently increase the total solids content of the resultant labneh treatments. Therefore, treatments that

exhibited the highest acidity contained the highest total solids (Gün and Işıklı, 2007; Mahdian and Tehrani, 2007 and El-Sayed et al., 2017). On the other hand, total solids, total protein and fat contents of all labneh treatments increased slightly as storage period advanced (Tables 2, 7), which might be due to the loss of moisture (Al-Otaibi and El-Demerdash, 2008, Atallah (2016) and Khodear (2018).

Table (1): Effect of adding probiotic bacteria on titratable acidity (%) and pH values of Labneh stored at 6 ± 1°C for 21 days.

Labneh Treatment*	Titratable acidity (%)				pH values			
	Storage period (days)				Storage period (days)			
	0	7	14	21	0	7	14	21
C◊	1.25	1.29	1.33	1.36	4.52	4.38	4.25	4.14
T_1	1.34	1.44	1.49	1.5	4.28	4.15	3.99	3.9
T_2	1.27	1.31	1.36	1.39	4.44	4.25	4.16	4.07
T_3	1.3	1.38	1.43	1.45	4.41	4.2	4.08	4
T_4	1.36	1.52	1.56	1.62	4.14	4	3.89	3.77

C◊: Control labneh made by adding 0.03% freeze dried conventional yoghurt starter culture containing *Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp. bulgaricus* (1:1).

T_1: Labneh made by adding 0.03% freeze dried conventional yoghurt starter culture + 1.00% *Lactobacillus acidophilus*.

T_2: Labneh made by adding 0.03% freeze dried conventional yoghurt starter culture + 1.00% *Bifidobacterium bifidum.*

T_3: Labneh made by adding 0.03% freeze dried conventional yoghurt starter culture + 1.00% *Lactobacillus plantarum*.

T_4: Labneh made by adding 0.03% Freeze dried conventional yoghurt starter culture + 0.33% from each of *L. acidophilus*, *Bifidobacterium bifidum* and *L. plantarum.*

Table (2): Effect of adding probiotic bacteria on gross composition of Labneh stored at 6 ± 1°C for 21 days.

Labneh Treatments*	Total Solids (%)				Total Protein (%)				Fat (%)				Ash (%)			
	Storage period (days)				Storage period (days)				Storage period (days)				Storage period (days)			
	0	7	14	21	0	7	14	21	0	7	14	21	0	7	14	21
Control	25.75	25.96	26.14	26.19	9.1	9.15	9.18	9.2	11.5	11.6	11.7	11.8	1.7	1.8	1.88	1.9
T_1	26.39	26.5	26.69	26.97	9.3	9.34	9.37	9.41	12.2	12.3	12.5	12.8	1.54	1.58	1.64	1.66
T_2	26.23	26.45	26.54	26.75	9.15	9.19	9.24	9.26	12	12.2	12.3	12.5	1.65	1.68	1.7	1.75
T_3	27.05	27.11	27.12	27.19	9.26	9.29	9.31	9.35	12.8	12.9	12.9	13	1.59	1.61	1.67	1.69
T_4	27.1	27.6	27.77	27.93	9.4	9.35	9.47	9.7	12.9	13	13.4	13.6	1.5	1.54	1.6	1.63

*** Each value in the table was the mean of three replicates.**

◊ See Table (1).

The ash and lactose contents of Labneh treatments followed almost similar trends (Tables 2,3,7). There were significant ($p \leq 0.05$) differences among Labneh treatments (Tables 2,3,7), which might be due to the differences in the titratable acidity of Labneh treatments. There is a negative correlation between the ash and lactose contents and the titratable acidity of Labneh treatments. Labneh treatments that had the highest titratable acidity contained the lowest ash and lactose contents (Tables 2,3,7), which might be due to dissolving some minerals by acidity and consequently loss these minerals in whey and subsequently decreases the ash content of the resultant Labneh treatments (Nergiz and Seckin, 1998 and Nsabimana et al., 2005), who reported that, the important losses occurred during manufacture and the highest losses were for minerals such as Na, K, Ca and P. Ash content of all Labneh treatments increased slightly as storage period proceeded (Tables 2,7). The increase may be due to the increase of total solids contents during the storage period. Similar trends were reported by El-Alfy et al. (2011) and Atallah (2016). The lactose content of all Labneh treatments decreased significantly ($p \leq 0.05$) as storage period proceeded (Tables 3, 7). The reduction of Lactose during storage could be attributed to the activity of lactic acid bacteria those ferment lactose to lactic acid during storage (Omer and Eltinay, 2009 and Ghalem and Zouaoui, 2013).

Acetaldehyde content

Changes of Acetaldehyde content during storage period of Labneh made with different starter are presented in Table (3). The diacetyl content of Labneh treatments followed similar trends of those of the actaldehyde content. The obtained results indicated that the acetaldehyde and diacetyl contents of all Labneh treatments increased during the first 7 days of storage period and reached their maximum concentration on the seventh day of storage period, then decreased gradually up to the end of storage period (Tables 3, 7). The reduction of acetaldehyde might be due to the reduction to ethanol (Tamime and Robinsonm, 1983 and El-Samragy et al., 1988). Similar trends were reported by Soad et al. (1997) and Al-Otaibi and El-Demerdash (2008), while decreasing of diacetyl might be due the reduction of diacetyl to acetone (Cogan, 1971). These results are in agreement with result reported for yoghurt by Badran (1986), Kebary et al. (2010)), Hamed et al. (2020). Labneh treatments were significant ($p \leq 0.05$) different from each other in the concentration of acetaldehyde and diacetyl contents, which means that the type of starter used in the manufacture of Labneh affected significantly ($p \leq 0.05$) the acetaldehyde and diacetyl contents of the resultant Labneh treatments (Tables3, 7). These results might be due to the different ability of each starter used in making Labneh in the production of the acetaldehyde and diacetyl (Soad et al., 1997 and Al-Otaibi and El-Demerdash, 2008). These microorganisms can ferment milk lactose to lactic acid, acetaldehyde and diacetyl (Hamdan et al., 1971 and Amarita et al., 2001). Treatment T4 that was made by starter containing L. acidophilus + Bif. bifidum + L. plantarum and treatment T3 that was made by L.plantarum contained the highest acetaldehyde and diacetyl contents were significantly different from other labneh treatments. These results might be due to the synergistic effects of these bacteria on their growth and consequently increasing the production of acetaldehyde and diacetyl.

Table (3): Effect of adding probiotic bacteria on Lactose, acetaldehyde and diacetyl content of Labneh stored at 6 ± 1°C for 21 days.

Labneh Treatment*	lactose content (%)				acetaldehyde content (ppm)				Diacetyl content			
	Storage period (days)				Storage period (days)				Storage period (days)			
	0	7	14	21	0	7	14	21	0	7	14	21
Control	3.45	3.41	3.38	3.29	24.28	39.14	30.74	25.69	7.84	12.47	11.58	9.61
T_1	3.35	3.28	3.18	3.1	48.54	52.12	50.47	47.14	27.14	32.82	29.53	22.1
T_2	3.43	3.38	3.3	3.24	40.98	49.05	43.36	40.6	20.25	29.11	20.08	15.52
T_3	3.4	3.31	3.24	3.15	51.96	55.87	53.67	50.32	27.97	33.71	30	28.22
T_4	3.3	3.2	3.1	3	59.48	64.71	57.98	52.58	29.51	35.12	32.79	30.94

*** Each value in the table was the mean of three replicates.**

◊ See Table (1).

Rheological properties It has been claimed that the manufacturing techniques and the total solids and total protein of Labneh had crucial effects on the rheology of Labneh (Nsabimana et al., 2005). The values of texture profile analysis of fresh Labneh and after 21 days of storage are presented in Table (4). The obtained results indicated that the texture parameters (Hardness, Adhesiveness, Cohesiveness, Springiness, Gumminess and Chewiness) followed almost similar trends (Tables 4, 8). There were significant difference among Labneh treatments in the values of Hardness, Adhesiveness, Cohesiveness, Springiness, Gumminess and Chewiness (texture parameters), which means that the starter culture affected significantly the rheological properties of the resulting Labneh. Treatment T4 that contained the highest total solids and total protein contents exhibited the highest values of texture parameters, while Treatment C which contained the lowest total solids and total protein contents exhibited the lowest values of texture parameters. These results might be due to the differences of total solids and total protein contents of Labneh treatments (Nsabimana et al., 2005; Saad et al., 2015 and El-Sayed et al., 2017) who stated that the rheological behavior of Labneh depended on the protein concentration.

On the other hand, most texture parameters of all Labneh treatments increased slightly while adhesiveness and springiness decreased slightly during the storage period (Tables 4, 8). These results might be due to the increase of total solids and total protein contents of all Labneh treatments as storage period proceeded. Similar trends were obtained by Mohamed et al. (2015), Mailam (2015), El-Sayed et al. (2017), Ibrahim (2017) and Ali (2018).

Changes of total bacterial counts during storage of Labneh treatments are presented in Table (5). The obtained results indicated that incorporating of probiotic bacteria caused a significant increase of the total bacterial counts of

the resulting Labneh treatments, which might be due to these bacteria were added beside addition of the normal yoghurt starter. Labneh treatment T4 exhibited the highest total bacterial counts, which might be due to the synergistic effect of these probiotic bacteria on each other. Total bacterial counts of Labneh treatments were different from each other, which might be due to the different abilities of producing antimicrobial agents thus suppress the growth of bacteria and consequently decrease the count of total bacteria and/or different ability to tolerate the developed acidity (Lorca et al., 2002 and Azcarate-Peril et al., 2004). Total bacterial counts of all Labneh treatments increased and reached their maximum counts on the seventh day of storage, then they were declined up to the end of storage period (Table 5), which might be due to the effect of the developed acidity and cold storage. Similar trends were reported by Al-Otaibi and El-Demerdash (2008), Nasser et al. (2017) and Abdel-sattar et al. (2019).

Table (4): Effect of adding probiotic bacteria on texture parameters of Labneh stored at 6± 1°C for 21 days.

Labneh Treatments*	Hardness (N)	Adhesiveness (mJ)	Cohesiveness (~)	Springiness (mm)	Gumminess (N)	Chewiness (mJ)
	0					
C◊	5	5.3	0.28	4.8	1.4	6.72
T_1	6.4	4.2	0.45	4.00	2.88	11.52
T_2	6.2	4.8	0.33	4.6	2.04	9.41
T_3	6.35	4.5	0.41	4.3	2.60	11.19
T_4	6.8	4.00	0.51	3.8	3.46	13.17
	21					
C◊	6.00	4.8	0.33	4.5	1.98	8.91
T_1	8.8	3.9	0.54	3.9	4.75	18.53
T_2	7.00	4.4	0.46	4.3	3.22	13.84
T_3	8.6	4.00	0.50	4.00	4.3	15.48
T_4	9.00	3.2	0.62	3.6	5.58	20.08

*** Each value in the table was the mean of three replicates.**
◊ See Table (1).

Table (5): Effect of adding probiotic bacteria on microbiological behaviour of Labneh stored at 6 ± 1°C for 21 days.

Labneh Treatments	T.C	*Lb. acidophilus*	*Bif. bifidum*	*Lb. plantarum*	Mould and yeast	Psy.c.
0						
C◊	7.42	-----	-----	-----	ND	ND
T_1	9.20	8.52	-----	-----	ND	ND
T_2	8.74	-----	7.1	-----	ND	ND
T_3	9.00	-----	-----	8.00	ND	ND
T_4	9.38	7.77	6.00	7.12	ND	ND
7						
C◊	7.78	-----	-----	-----	ND	ND
T_1	9.51	8.64	-----	-----	ND	ND
T_2	8.98	-----	7.24	-----	ND	ND
T_3	9.25	-----	-----	8.44	ND	ND
T_4	9.70	7.81	6.36	7.45	ND	ND
14						
C◊	7.7	-----	-----	-----	2.00	ND
T_1	9.42	8.61	-----	-----	ND	ND
T_2	8.79	-----	7.12	-----	2.5	ND
T_3	9.1	-----	-----	8.34	ND	ND
T_4	9.61	7.72	6.20	7.34	ND	ND
21						
C◊	7.20	-----	-----	-----	3.4	ND
T_1	9.00	8.43	-----	-----	ND	ND
T_2	8.5	-----	7.00	-----	2.9	ND
T_3	8.8	-----	-----	8.29	ND	ND
T_4	9.20	7.51	6.12	7.00	ND	ND

T.C = Total bacterial counts.
Psy.C.= Counts of psyhrotrophic bacteria.
◊ See Table (1). ND = Not detected. --- Not determined

The count of each probiotic bacteria (L. acidophilus, Bif. bifidum and L. plantarum) was determined in Labneh treatments those were made by adding each bacterial strain (Table 5). Labneh treatments T1,T2 and T3 exhibited higher counts of L. acidophilus, Bif. bifidum and L. Plantarum, respectively, than those of treatment T4 in the same order, which might be due to the amount added of these bacteria during the manufacture of Labneh treatments (Table 5). Comparing the counts of each bacterial strains, the counts of L. acidophilus were the highest followed by the counts of L. plantarum and then the count of Bif. bifidum. These results might be due to the ability to tolerate the development of acidity, whereas L. acidophilus could tolerate the acidity, on the contrary the growth of Bif. bifidum could be affected by acidity (Dave and Shah, 1997; Kailasapathy and Rybka, 1997; Lorca et al., 2002 and Azcarate-Peril et al., 2004). The probiotic bacteria followed almost similar trends (Table 5), all probiotic bacteria increased and reached their maximum counts on the seventh day of storage then their counts were reduced as the storage period progressed (Table 5), which might be due to the cold storage and/or the developed acidity. Similar results were reported by Martin and Choe (1992), Kebary et al. (2008), Abd-Elsatar et al.

(2019). The counts of each probiotic strain even after 21 days of storage were higher than the counts of these bacteria should be present to achieve their health benefits for the consumers (106), therefore, probiotic Labneh could be a good product for delivering the probiotic bacteria to the consumers.

Data in Table (5) show that moulds and yeasts were not detected in all Labneh treatments during the first 7 days of storage, which might be due to following good hygienic conditions during the manufacture of Labneh. Moulds and yeasts appeared on the fourteenth day of storage in control Labneh treatment and T2 that was made by adding Bif. bifidum and increased towards the end of storage period (Table 5). On the other hand, moulds and yeasts were not detected in Labneh treatments those made by adding L. acidophilus or L. plantarum which might be due to the production of antimicrobial agents, especially antifungal agents (Ghazvini et al., 2016; Russo et al., 2017 and Radi et al., 2017). Psychrotrophic bacteria were not detected in all Labneh treatments at any time of storage period (Table 5) (Yu et al., 2013 and Ołdak et al., 2017).

Scores of organoleptic properties (flavours, body and texture and appearance of all Labneh treatments are presented in Table (6). Scores of flavour, body and texture and the total scores of organoleptic properties, followed similar trends (Tables 6 and 9). The obtained results indicated that there were significant ($p \leq 0.05$) differences among Labneh treatments, which means that the type of starter affected the scores of organoleptic properties (Tables 6, 9). Incorporation of probiotic bacteria during the manufacture of Labneh treatments improved their acceptability and subsequently increased the scores of flavour, body and texture and the total scores (Tables 6, 9). Although all Labneh treatments were accepted by the panelist, T3 that made by adding L. plantarum was the most acceptable Labneh treatment and gained the highest scores of organoleptic properties (Sharal et al., 1996). On the other hand, scores of organoleptic properties did not change significantly during the first 7 days of storage period, then the scores were declined up to the end of storage period (Tables 6, 9). These results are in agreement with those reported by Al-Otaibi and El-Demerdash (2008), Salem et al. (2013), El-Sayed et al. (2017), Nasser et al. (2017), Abd El-Sattar et al. (2019).

It could be concluded that incorporation of probiotic bacteria during the manufacture of Labneh increased the titratable acidity, total solids, protein, fat, acetaldehyde and diacetyl contents of the resulting Labneh treatments, while decreasing the ash and lactose contents. It also increased all the values of texture parameters (hardness, Adhesiveness, Cohesiveness, Springiness, Gumminess and Chewiness), viscosity and improved the acceptability of Labneh treatments. The most acceptable treatment was T3 that was made by adding L. plantarum. On the other hand, total solids, fat, total protein contents, titratable acidity, texture parameters, viscosity increased slightly during the storage period, while pH values were decreased. The counts of probiotic bacteria of Labneh treatments those made by adding these bacteria, even at the end of storage period were higher than the numbers should be present in food products to achieve their health benefits. Therefore, probiotic Labneh could be a good vehicle for delivering the probiotic bacteria to consumers.

Table (6): Effect of adding probiotic bacteria on sensory evaluation of Labneh stored at 6 ± 1°C for 21 days.

Labneh Treatments	Flavour (50)	Body & texture (40)	Appearance (10)	Total
	0			
C◊	41	37	10	88
T_1	46	39	10	95
T_2	43	38	10	91
T_3	49	40	10	99
T_4	45	38	10	93
	7			
C◊	41	37	9	87
T_1	46	39	9	94
T_2	43	38	9	90
T_3	49	40	9	98
T_4	45	38	9	92
	14			
C◊	39	31	6	76
T_1	44	35	7	86
T_2	41	33	6	80
T_3	47	38	8	93
T_4	42	34	6	82
	21			
C◊	34	29	6	69
T_1	39	33	6	78
T_2	37	31	6	74
T_3	44	35	7	86
T_4	35	32	6	73

◊ See Table (1).

Table (7). Statistical analysis of chemical composition of Labneh stored at 6 ± 1°C for 21 days.

Labneh properties	Effect of treatments						Effect of storage period (days)				
	Multiple comparison•						Multiple comparison•				
	Mean Squares	C◊	T_1	T_2	T_3	T_4	Mean Squares	0	7	14	21
Acidity	0.156*	E	B	D	C	A	0.349*	D	C	B	A
pH	0.010*	A	D	B	C	E	0.019*	A	B	C	D
Total solid	2.703*	D	B	CD	C	A	16.008*	C	BC	AB	A
Protein	2.568*	D	AB	CD	B C	A	15.212*	C	BC	ABC	A
Fat	17.400*	D	AB	C	B	A	65.126*	C	BC	ABC	A
Ash	0.010*	A	CD	AB	BC	D	0.213*	C	BC	AB	A
Lactose	0.055*	A	D	B	C	E	0.105*	A	B	C	D
Acetaldehyde	2421.97*	D	B	C	AB	A	126.313*	D	A	B	C
Diacetyl	1390.06*	D	B	C	AB	A	52.036*	D	A	B	C

◊ See Table (1).

• For each effect the different letters in the same row means the multiple comparisons are different from each other, letter A is the highest mean followed by B, C, …. etc.

* Significant at 0.05 levels ($p \leq 0.05$).

Table (8). Statistical analysis of rheological properties of Labneh stored at 6 ± 1°C for 21 days.

Texture parameters	Effect of treatments						Effect of storage period		
	Multiple comparison•						Multiple comparison•		
	Mean Squares	C◊	T_1	T_2	T_3	T_4	Mean Squares	0	21
Hardness (N)	0.593*	D	B	C	B	A	5.043*	B	A
Adhesiveness (mJ)	2.986*	D	B	C	B	A	40.549*	A	B
Cohesiveness (~)	0.057*	C	AB	C	B	A	0.097*	B	A
Springiness (mm)	1.652*	D	AB	C	B	A	119.520*	A	B
Gumminess (N)	0.199*	C	AB	BC	AB	A	2.403*	B	A
Chewiness (mJ)	8.896*	D	AB	C	B	A	1.786*	B	A

◊ See Table (1).

● For each effect the different letters in the same row means the multiple comparisons are different from each other, letter A is the highest mean followed by B, C, …. etc.

* Significant at 0.05 levels ($p \leq 0.05$).

Table (9). Statistical analysis of sensory evaluation of Labneh stored at 6 ± 1°C for 21 days.

Labneh properties	Effect of treatments						Effect of storage period (days)				
	Multiple comparison•						Multiple comparison•				
	Mean Squares	C◊	T_1	T_2	T_3	T_4	Mean Squares	0	7	14	21
Flavour	91.125*	D	B	C	A	B	228.550*	A	A	B	C
Body& texture	99.375*	D	B	C	A	B	114.950*	A	A	B	C
Appearance	0.600*	B	AB	AB	A	AB	37.350*	A	A	B	C
Total	273.525*	D	B	C	A	B	939.200*	A	A	B	C

◊ See Table (1).

● For each effect the different letters in the same row means the multiple comparisons are different from each other, letter A is the highest mean followed by B, C, …. etc.

* Significant at 0.05 levels ($p \leq 0.05$).

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تحسين خواص اللبنة وفوائدها الصحيه باستخدام البكتريا الداعمة للحيوية

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الملخص العربي

اللبنه تعتبر واحده من اشهر المنتجات المتخمره في منطقة الشرق الأوسط وبدأ انتاجها واستهلاكها يتزايد حديثا في السوق المصري ونظرا للفوائد الصحيه المتعدده للبكتريا الداعمة للحيويه فقد اهتمت الأبحاث حديثا بمحاولة إضافتها لمنتجات الالبان بغرض زيادة فوائها الصحيه لذلك.

يهدف هذا البحث الي إضافة البكتريا الداعمة للحيوية الي اللبنه ودراسة تأثيرها علي صفات اللبنه الناتجه لذلك فقد تم تصنيع خمس معاملات من اللبنه ز المعامله الاولي وهي الكونترول صنعت باستخدام بكتريا اليوجورت المعروفه (C)وكذلك صنعت ثلاث معاملات بإضافة بكتريا اليوجورت بالإضافة الي إضافة ١٪ من كل من البكتريا الآتيه التي *L.acidophilus(T1), Bifidobacterium bifidum (T2), and L.plantarum(T3)* أضيفت بمفردها وهي.

أما المعامله الخامسة (T4) صنعت بإضافة بكتريا اليوجورت بالإضافة الي إضافة ٠.٣٣٪ من كل من البكتريا الثلاث السابقة أي خليط من البكتريا الداعمة للحيوية ولقد تم حفظ اللبنة علي درجة حرارة الثلاجه لمده ٢١ يوم حيث اخذت عينات اللبنه وهي طازجه وبعد كل ٧ أيام وذلك للتحليل الكيماوي واالريولوجي والميكروبيولوجي والتقييم الحسي ولقد أوضحت النتائج المتحصل عليها ما يلي :

١-اختلفت معاملات اللبنه فيما بينها في كل من الحموضه و pH والتركيب الكيماوي والصفات الريولوجيه والتقييم الحسي نتيجة استخدام الأنواع المختلفه ممن البكتريا الداعمة للحيويه

٢- احتوت المعاملة T4وهي المصنعه بإضافة خليط من البكتريا الداعمة للحيوية علي اعلي نسب من كل من الحموضه، الجوامد الصلبه الكليه ، البروتين الكلي ،الدهن ،الاسيتالدهيد ، الداي استايل وأعلي قيم للخواص الريولوجيه مثل Hardness, Adhesiveness, Cohesiveness, Springiness, Gumminess and Chewiness وكانت متفاوتة من المعامله T3 المصنعة بإضافة *L.plantarum* حصلت علي اعلي درجات التحكيم الحسي وكانت اكثر العينات قبولا

٤-إزدادت نسب كل من الحموضه والجوامد الصلبه الكليه والدهن والبروتين الكلي والرماد أثناء التخزين في حين انخفضت قيم pH واللاكتوز بتقدم فترة التخزين

٥- إزداد العدد الكلي للبكتريا وكذلك اعداد البكتريا الداعمه للحيويه في كل العينات حتي اليوم السابع حيث وصلت لأقصي عدد ثم بدأت تقل اعداد هذه البكتريا بتقدم فترة التخزين.

٦- ظلت اعداد البكتريا الداعمه للحيويه في المعاملات التي أضيفت لها وحتي بعد مرور ٢١ يوم علي أعداد اعلي من تلك المفترض تواجدها في المنتج لتحقيق الفوائد الصحيه لها مما يرجح إمكانية استخدام اللبنة كوسيلة جيده لانتاج منتج وظيفي جيد داعم للحيويه.

السادة المحكمين

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