ISSN: 2754-477X

Journal of Food Technology & Nutrition Sciences

SCIENTIFIC Research and Community

Research Article

Open Access

Impact of Using Jerusalem Artichoke Tubers Powder and Probiotic Strains on some Properties of Labneh

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ABSTRACT

Bio-Labneh was produced from cow's milk using Jerusalem artichoke tubers powder (JATP) inoculated by *Lactobacillus acidophilus* LA-5. The effect of different concentrations (1, 3 and 5%) of JATP on the chemical composition, organoleptic properties and the growth, and activity of *Lactobacillus acidophilus* LA-5 were investigated. Significant differences were observed in the chemical composition and counts of viable bacteria between treatments either in fresh or stored Labneh. Acidity % in all treatments was significantly increased and pH was decreased with increasing storage period. The viable count of *Lactobacillus acidophilus* was also increased through the first 7 days then decreased gradually during the storage period. Generally, using JATP in manufacturing bio-Labneh had acceptable with 1% JATP, while 3% JATP received the highest total scores and the growth of *Lactobacillus acidophilus* LA-5.

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Received: February 19, 2021; **Accepted:** February 24, 2021; **Published:** February 27, 2021

Keywords: Bio-Labneh, Jerusalem artichoke, *Lactobacillus acidophilus* La-5, Properties

Introduction

Milk fermentation is one of the oldest methods practiced by the human beings to preserve milk with an extended shelf-life [1,2]. Fermented dairy products containing useful living micro-organisms have traditionally been used to restore gut health, being among the pioneers in functional foods. Such utilization of live micro-organisms forms the basis of the probiotic concept, which constitutes a fast growing Market for the development of new products [3]. Probiotics are bacterial members of the normal human intestinal microbiota that promote several beneficial effects on human health. They produce short-chain fatty acids and improve the intestinal microbial balance, resulting in the inhibition of bacterial pathogens, reduction of colon cancer risk, improving the immune system and lowering serum cholesterol levels Labneh, Labaneh, Lebna, Labne, and Labanah are all synonyms to Labneh. It is a fermented dairy product used mainly to spread on sandwiches, particularly for breakfast meals [4]. As Labneh is a semisolid product depending on total solids content, it is spreadable and has a slightly pleasant acidic Flavour.

Many names (~400) are applied to the traditional and modem fermented and concentrated fermented milks. The particular names of these concentrated fermented milks Depend upon: region of the world, type of milk used (cow, goat, sheep or Buffalo), microbial cultures that dominate(s) the flora and borrowed or made-up names [5].

Jerusalem artichoke (*Helianthus tuberosus* L.) is a native plant of the North American plains cultivated for different purposes in many countries. it is a natural raw material that contains a high amount of dietary fiber namely inulin and fructooligosaccharides and having both nutritional and functional attributes, particularly beneficial to individuals with Type 2 diabetes and obesity. [6-9]. Used Helianthus tuberous (Jerusalem artichoke)as supplement at levels 3, 5 and 7% to product function yoghurt to enhance native value health benefits and to improve rheological, phyisco-chemical and sensory properties of final product.

So, the present study aimed to use Jerusalem artichoke tubers powder to develop as a healthy food choice for people such as diabetes and production of new Labneh with high biological value and studying the health benefits of Jerusalem artichoke as prebiotic on the activity of *Lactobacillus acidophilus*.

Materials and Methods

Materials

Fresh cow's milk was obtained from a private farm. Jerusalem artichoke tubers (*Helianthus tuberosus*) harvested in December 2019 were obtained from the Experimental Station, Agriculture Research Center, Dokki, Giza, Egypt. Table salt was obtained from a local market.

Starter culture

Yoghurt culture which consists of *Streptococcus thermophilus* & *Lactobacillus bulgaricus* and *Lactobacillus acidophilus* LA-5 (Freeze-Dried Red-Set) were obtained from Chr. Hansen

Laboratories, Copenhagen, Denmark. The working culture was prepared by adding few milligrams from the freeze-dried culture to 100 ml of sterile reconstituted skim milk. This mixture was then incubated at 42°C until the onset of gelation. Two milliliters of the mother culture from this passage were transferred into 100 ml of sterile skim-milk at 42°C and incubated until a gel had just formed.

Methods

Preparation of Jerusalem artichoke tubers powder

Jerusalem artichoke tubers were washed with tap water and any deteriorated parts were removed, then the tubers were sliced conventional food slicing machine. The sliced tubers were immersed immediately in boiling water for 5 min, following by immediate dipping in cold citric acid solution (1%) to inhibit polyphenoloxidases activity. The tuber slices were dried in an electronic air oven at 54-55°C until samples reached constant weight and then powdered using hammer mill and sieved through 40-mesh sieve. Then the obtained Jerusalem artichoke tubers powder was kept at -18°C until use.

Labneh manufacture

The traditional method of making yoghurt [10]. was followed including heating milk at 90°C for 15 min, cooling to 42°C, inoculating with yoghurt starter culture) *Lactobacillus bulgaricus* & *Streptococcus thermophiles*) (1:1) and *Lactobacillus acidophilus* LA-5 as well as probiotic culture and the complete coagulation was Followed by cooling overnight in the refrigerator. Labneh manufacture by the method which described by as followed [11].

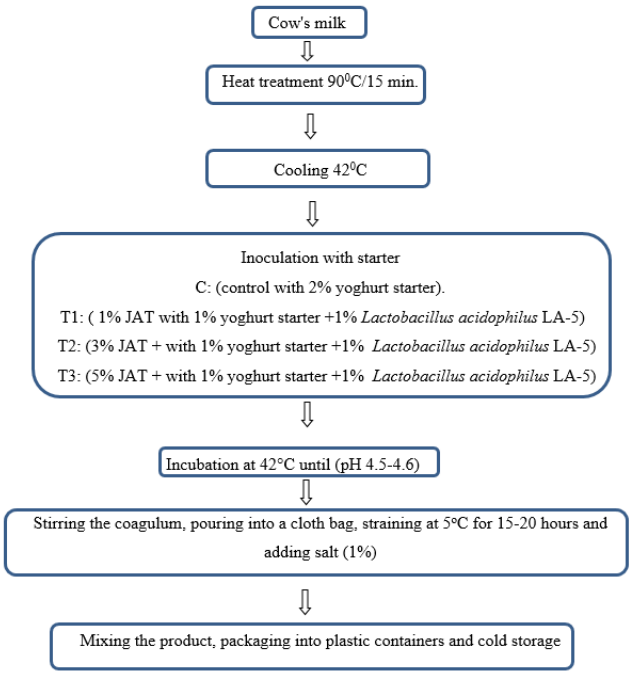

Figure 1: Schematic diagram of manufacturing steps of Labneh by using JAT powder and probiotic starter

Chemical analysis

For each parameter, samples were analyzed in three replicates. The content of total solids content, protein, ash, fat, SN and titratable acidity were determined according to the method as described by [12].The pH of samples was determined using pocket pH meter (IQ Scientific USA, Model IQ 125). Crude fiber was determined by dilute acid and alkaline hydrolysis. Carbohydrate content was determined by differences of total contents (total solids, protein, fat and ash) from 100 and that of Jerusalem artichoke tubers powder using Soxtec (Foss instrument, Sweden) Acetaldehyde contents was determined according to [13,14]. Inulin was determined according to [15].

Microbiological estimation

Labneh containers were wiped, from the outside, with 70% ethanol and their contents were thoroughly mixed with a sterile spatula. Total bacterial counts, yeasts and moulds and coliforms were determined according to standard procedures [16]. *Lactobacillus acidophilus* LA-5 was determined using lactobacillus selective agar plus 0.2 Oxgell (LBSO) [17]. The plates were incubated at 37°C for 48 hours.

Organoleptic properties

The organoleptic properties included flavor 60 points; body and texture 30 points and appearance was given score of 10 points [18, 19]. The organoleptic evaluations were done by 10 of staff members.

Statistical analysis

Statistical analysis for the obtained data was carried out according to the methods which described by [20].

Results and Discussion

Chemical composition of Jerusalem artichoke tubers powder

Table (1) shows that the total solids content of Jerusalem artichoke tubers powder were 91.65%. Total carbohydrates, crude protein, crude fiber and ash contents were 75.65, 7.10, 3.65 and 5.09%, respectively. These results were in line with the results mentioned by [8], who found the chemical composition of Jerusalem artichoke tuber to be: 92.68, 74.57, 7.60, 3.81, 70.79 and 5.12 g/100 g, for total solids, total carbohydrate, crude protein, crude fiber, inulin and ash, respectively. The carbohydrates content of Jerusalem artichoke tubers were mainly in the form of inulin. To date inulin has been increasingly used as functional ingredients in processed food due to its unique characteristics. Also, the Jerusalem artichoke tubers can be considered as a good source of fiber.

Table 1: Average Chemical composition of Jerusalem artichoke tubers powder

(JAT) powder	TS	Ash	Crude fiber	Crude protein	Total carbohydrate	Inulin
Sample%	91.65±2.15	5.09±0.5	3.65±0.0	7.10±0.0	75.65±0.86	68.20±1.15

In this study, the protein content of the tubers was 7.10%, which is in agree with [8,21] and higher than that reported by [7]. These differences in tuber composition might be related differences in to the variety of the tubers used.

Chemical composition of Labneh

Total solids content

Data in Figure (2) revealed the total solids (TS) content (%) of the Labneh made from cow's milk using probiotic bacteria and different concentrations of Jerusalem artichoke powder (JATP). The TS contents (%) were 22.75, 23.60, 25.05 and 26.13% in fresh Labneh made from different treatments C, T1, T2 and T3 respectively. After one week the values were 22.91, 23.81, 25.25 and 26.24%, while after two weeks the values were 22.93, 23.93, 25.32 and 26.29%. At the end of storage period, the values were 22.95, 24.20, 25.40 and 26.36%. From the above it is clear that differences between Labneh treatments were significant ($P<0.01$), whereas in control samples had insignificant effect on TS of Labneh ($P>0.01$).

Total solids content of Labneh in the treatment (T3) were 26.13, 26.24, 26.29 and 26.36% in fresh Labneh and after 1, 2 and 3

weeks, respectively. The TS of Labneh in the treatments T1, T2 and T3 increased significantly (P<0.01) during storage period. The maximum TS contents were at the last week of storage. They were 24.20, 25.40 and 26.36% for T1, T2 and T3 respectively. Mentioned that the TS content of Labneh ranged from 20.54 to 24.61, whereas reviewed some more recent studies (1987-1997) and mentioned that the TS ranged from 23.3 to 26.1%. A highly significant difference were given by

Concerning TS content of commercial Labneh products collected from the Labanese market [22-24]. However, the changes of TS in the present study due to adding of different growing concentration of JATP, these results are agreement with [8]. Impact of adding JATP on TS agree with the findings of who gave values of 19.34, 19.68 and 20.11% for TS of yoghurt supplemented with B5, S5 and G5 in order, while the control yoghurt had only 15.89% TS. Also, was in line with who made probiotic Labneh using date powder prepared from different cultivatrs [25,26].

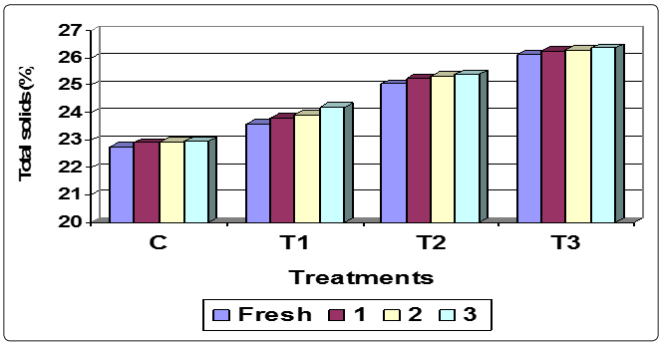

Figure 2: Effect of using JAT powder and probiotic strain on TS % of Labneh

Fat content

It is clear from Figure (3) that the differences between the treatments affected significantly (P<0.01) the fat content (%) of the resultant Labneh. The values were 6.18, 6.15, 6.20 and 6.20% for fresh Labneh made from C, T1, T2 and T3 respectively. Such significant differences were noticed for Labneh of any age during could storage of three weeks. The corresponding values at the end of storage were 6.22, 6.08, 6.10 and 6.15% in order. Slight decreases the fat contents in all treatments were found during cold storage which may be due to lipolytic effect of probiotic Labneh culture.

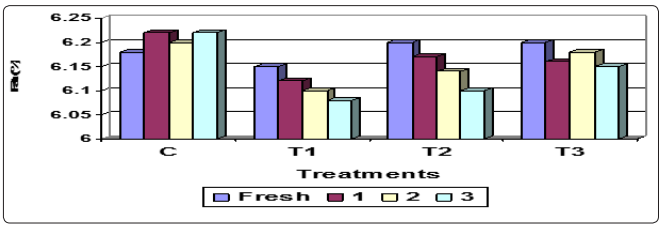

Figure 3: Effect of using JAT powder and probiotic strain on fat % of Labneh

Storage period had significant effect (P<0.01) on fat content (%) of all Labneh samples made of different treatments. These results are disagreement with who found that insignificant difference between treatments when made yoghurt or Labneh using JATP or date powder [8, 25, 26]. The slight changes in fat during storage were also given by [27].

Fat on dry matter (FDM) content

Fat on dry matter are shown in Figure (4). It seems from given data that FDM had significantly differences between the treatments (P<0.01). The values were 27.16, 26.06, 24.75 and 23.73% for fresh Labneh made from C, T1, T2 and T3 respectively. Such significant differences were noticed for Labneh of any age during could storage of three weeks. The corresponding values at the end of storage were 27.10, 25.12, 24.02 and 23.33% in order. Storage period had significant effect (P<0.01) on FDM content (%) of all Labneh samples made of different treatments. A gradual decrease were observed in FDM was recorded that may be due the corresponding increase in TS. These results are agreement with who found that significant difference between treatments when made yoghurt or Labneh using JATP or date powder [8, 25, 26].

Protein Content

It seems from the given data shown in Figure (5) that protein of Labneh samples from C, T1, T2 and T3 treatments contained protein 7.30, 7.40, 7.53 and 7.58%, respectively. Such changes were almost significant (P<0.01). The changes in protein during storage were almost significant. The present results suggest that protein content was significantly increased when JATP was added to the prepared Labneh. The increase was pronounced when JATP was added at 1% level and such increase was more and more in case of treatment T3. This may be due to JATP contained more protein.

The changes in protein of zabady as affected by supplementation with date powder were insignificant with disagree with the trend given by since during storage of Labneh for 1, 7, 14 and 2l days the recorded protein contents were 9.15, 9.24, 9.33 and 9.41% respectively [25-27]. Also these results are in agree with, who found that protein of Labneh samples made with date powder from treatments B5, B10, S5, S10, G5 and Gl0 contained protein 8.51, 9.65, 8.69, 8.62, 8.66, 9.66, 9.72%, respectively [26]. A slight decline of protein content was observed at the end of cold storage period and this may be attributed to the limited proteolytic effect of different bio-yoghurt cultures [8, 28].

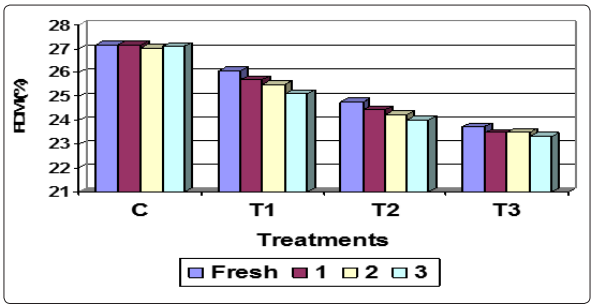

Figure 4: Effect of using JAT powder and probiotic strain on fat on dry matter, FDM (%) of Labneh.

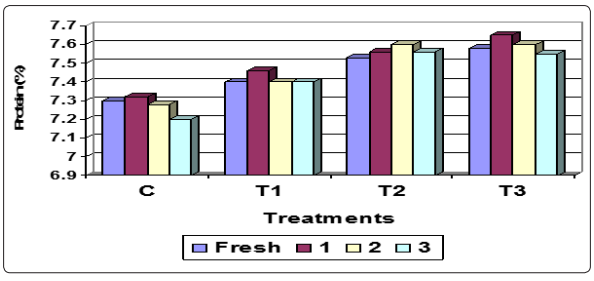

Figure 5: Effect of using JAT powder and probiotic strain on protein content (%) of Labneh

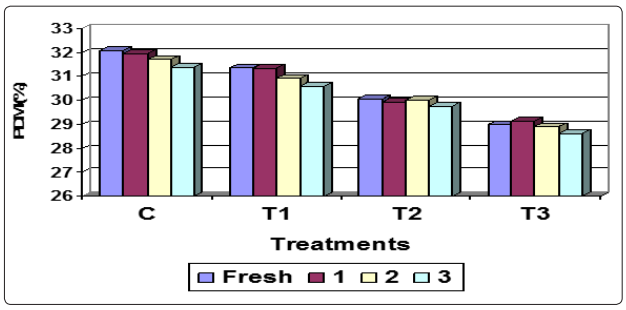

Figure 6: Effect of using JAT powder and probiotic strain on protein on dry matter, PDM (%) of Labneh

Protein on Dry mater content PDM

It seems from the given data in Figure (6) that protein on dry matter content PDM (%) of fresh Labneh samples from treatments C, T1, T2 and T3 values were 32.09, 31.36, 30.06 and 29.00%, respectively (P<0.01), and was at the end of the storage period 31.37, 30.58, 29.76 and 28.64 in C, T1, T2 and T3 respectively.

A gradual decrease in PDM was recorded that may be due to the corresponding increase in TS. The present results suggest that PDM was higher in C when compared with those of JATP-supplemented Labneh that may be due to the C contained much less total solids content . The changes in protein of zabady as affected by supplementation with JATP were slight decrease in PDM of the present study during storage and in agree with who found that PDM of Labneh samples made with date powder from treatments B5, B10, S5, S10, G5 and Gl0 contained protein 35.33, 30.36, 27.68, 30.38, 27.33, 33.97, 30.90%, respectively [25,26].

Ash content

As expected, the higher was the amount of JATP added, the higher was ash content of the prepared Labneh. This was true in Labneh supplemented JATP used. Figure (7) shows that the fresh C contained 0.85% ash, while adding JATP at 1, 3 and 5% increased ash to reach 0.89, 0.92 and 0.94% in order. Table (2) reveals also that in 1 week old Labneh were 0.88, 0.91, 0.94 and 0.94% (P< 0.01) in 2 weeks old Labneh were 0.90, 0.93, 0.92 and 0.93% (P< 0.01) in 3 weeks old Labneh were 0.92, 0.95, 0.95 and 0.98% in the treatments C, T1, T2 and T3 respectively. These agree with, who found that ash content from all treatments of bio-yoghurt slightly increased throughout the storage period [8]. The ash content of bio-yoghurt was significantly (p<0.01) effect on the ash content in line with adding JATP and insignificantly with the type of the starter culture.

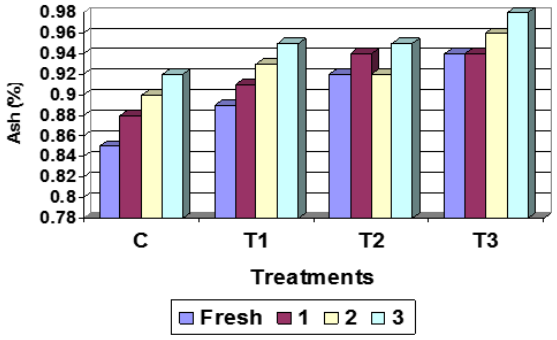

Figure 7: Effect of using JAT powder and probiotic strain on Ash content (%) of Labneh

Titratable acidity and pH values of cow milk Labneh

As shown in Figure (8) and (9), acidity significantly increased and pH decreased (P< 0.01).Thus, the acidity values were 1.12, 1.15, 1.16 and 1.18 % for fresh Labneh in the treatments C, T1, T2 and T3 respectively. The treatment C was the lower acidity value (1.12) %, but the treatment T3 was the highest acidity value (1.18) % in fresh probiotic Labneh, whereas those of 1 week old Labneh were 1.15, 1.17, 1.19 and 1.21% (P< 0.01) in 2 weeks old probiotic Labneh were 1.18, 1.20, 1.17 and 1.20% (P< 0.01) in 3 weeks old probiotic Labneh were 1.18, 1.22, 1.22 and 1.22% in the treatments C, T1, T2 and T3 respectively. The increase in acidity due to the use of JATP is agree with, who showed that adding of DP from B, S and G date cultivars increased acidity of yoghurt from 0.70 to 0.79, 0.80 and 0.75% in order [25]. Also these results were in accordance with , who showed that the acidity values of yoghurt in all treatments were increased during storage with different rates according to the starter culture used, while the pH was decreased [8].

In the other hand, control sample (C) had the highest pH value (4.65), but the treatment T3 had the lowest pH values (4.50) in fresh probiotic Labneh. Thus, pH values were 4.65, 4.60, 4.55 and 4.50 in fresh Labneh whereas those of 1 week old probiotic Labneh were 4.61, 4.57, 4.56 and 4.46 (P< 0.01) in 2 weeks old probiotic Labneh were 4.60, 4.51, 4.51 and 4.46 (P< 0.01) in 3 weeks old probiotic Labneh were 4.54, 4.50, 4.52 and 4.40 in the treatments C, T1, T2 and T3 respectively. This suggests a decrease in pH with supplementation of Labneh with JATP and a gradual decrease with advancing storage period. Such decrease was in agreement with finding of [25, 29] during storage of yoghurt supplemented with rutub date. The results showed that the probiotic Labneh treatments contained relatively the highest acidity until the end of storage period. The trend of the changes in pH values of all treatments was oppsite to that of acidity which may be led to more lactic acid production as a result of microorganism metabolism. Moreover, it was found that the majority of *Lactobacillus acidophilus* (LA-5) strain showed a medium or slow rate of acidification .The titratable acidity values of the control and probiotic Labneh trended to decreased during storage. Such decreases disagree with finding of [8].

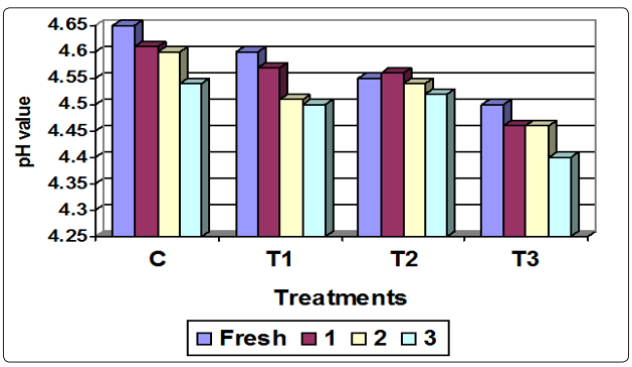

Figure 8: Effect of using JAT powder and probiotic strain on pH values of cow milk Labneh

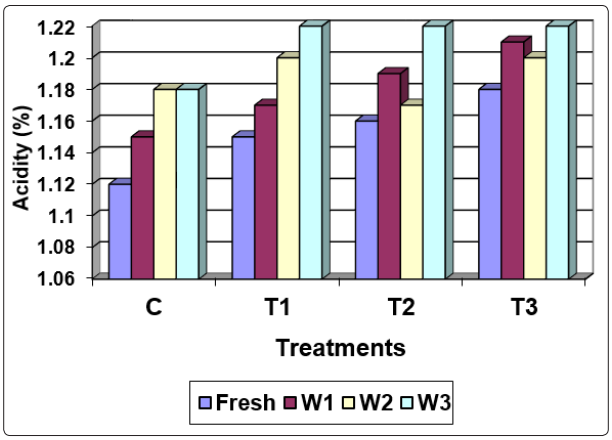

Figure 9: Effect of using JAT powder and probiotic strain on acidity (%) of Labneh

Microbiological analysis

Total bacterial count (TBC)

Total bacterial counts (log CFU/g) of Labneh are shown in Table (2). The total bacterial count (TBC) of Labneh samples made by using different concentration of JATP recorded a gradual increase in line with increase adding of JATP. Counts of fresh Labneh (log CFU/g) were 8.24, 8.30, 8.40 and 8.42, while after one week of cold storage were 8.25, 8.40, 8.45 and 8.50 after two weeks were 8.20, 8.40, 8.35 and 8.40 and after three weeks of storage the counts were 7.95, 8.30, 8.20 and 8.18 in Labneh from treatments C, T1, T2 and T3 respectively.

Counts of *L. acidophilus* bacteria

It is clear of significant differences in counts due to treatments. The viability of *Lactobacillus acidophilus* LA-5 in Labneh supplemented with JATP during storage period at 5 ºC is presented also in Table (2). The log count of *Lactobacillus acidophilus* LA-5 were 8.20, 8.20 and 8.25 (log CFU/g) in the treatments T1, T2 and T3 respectively at zero time. After the first week of storage the counts were 8.30, 8.52 and 8.25, while after two weeks they were 8.25, 8.40 and 8.11 respectively. At the end of storage period the counts (log CFU/g) were 8.25, 8.35 and 7.95. From the above we can conclude that the treatment Labneh T2 had the highest counts of *L. acidophilus* LA-5 and can grow and reduce the pH, while Labneh of treatment T3 had the lowest counts that mean retarding impact of JATP in this respect. Also, when we studied the effect of storage period we found that it had a significant effect on counts of *L. acidophilus*.

The count of *Lactobacillus acidophilus* LA-5 was increased and after that decreased in the end of storage period. The decrease in the viable of *Lactobacillus acidophilus* LA-5 count in all treatments may be due to the effect of the developed acidity, Results are in agreement with, who reported that the *Lactobacillus acidophilus* LA-5 can grow and reduce the pH [8,30].

The lactic acid bacterial count of the Labneh fortified with 3% JATP powder was also increased after 7 days of production date. The observation had also shown by on their petit-Suisse cheeses supplemented with oligofructose and inulin [31]. On the other hand, the viable count of *Lactobacillus acidophilus* was also increased through the first 7 days then decreased gradually during the storage period. The decline in the viable count may be attributed to the effect of post acidification [32, 33]. In general, the gradual decrease in counts of *L. acidophilus* during storage of Labneh was attributed in some studies to sensitivity of this bacteria and the probiotic bacteria- in general- to the acid formed by lactose fermentation as well as oxygen content of the product and the antibacterial substances produced by lactic acid bacteria [34, 35].

Table 2: Total bacterial count and count of bacterial spp. (log CFU/g) of Labneh during storage at 5ºC

Treatments	T.C	*Str. th.*	*Lb. bulg.*	*Lb. acid.*
Fresh (0 day)				
C	8.24	7.26	7.25	ND
T1	8.30	7.34	7.30	8.20
T2	8.40	7.35	7.40	8.20
T3	8.42	7.35	7.40	8.25
After 1 week				
C	8.25	7.30	7.25	ND
T1	8.40	7.45	7.35	8.30
T2	8.45	7.39	7.50	8.52
T3	8.50	8.40	7.20	8.25
After 2 weeks				
C	8.20	7.25	7.20	ND
T1	8.40	7.39	7.35	8.25
T2	8.35	7.34	7.40	8.40
T3	8.40	8.32	7.06	8.11
After 3 weeks				
C	7.95	7.00	7.05	ND
T1	8.30	7.20	7.35	8.25
T2	8.20	7.30	7.30	8.35
T3	8.18	8.28	7.00	7.95

C: (control with 2% yoghurt starter).
T1: (1% JAT with 1% yoghurt starter +1% *Lactobacillus acidophilus* LA-5)
T2: (3% JAT + with 1% yoghurt starter +1% *Lactobacillus acidophilus* LA-5)
T3: (5% JAT + with 1% yoghurt starter +1% *Lactobacillus acidophilus* LA-5).
Lb. acid. : *Lactobacillus acidophilus* LA-5
T.C : Total bacterial count
Str. th. :*Streptococcus thermophiles*
Lb. bulg. :*Lactobacillus bulgaricus*
ND: not detected

The organoleptie properties

Figure10: shows scoring points of the organoleptic properties of Labneh prepared from different treatments when fresh and during storage. The results of sensory evaluation of the prepared Labneh on the basis of appearance, consistency and flavour based on the effect of adding different concentration of JATP and *Lactobacillus acidophilus* LA-5 on cow's milk Labneh are summarized in Figure (10). The treatment fresh Labneh (T3) had the lowest scores being 7, 28 and 53 out of 10, 30 and 60 in Appearance, consistency and flavor, respectively. It can be seen that the changes in the organoleptic properties was unlike with the increase in concentration of JATP. the total organoleptic properties values were 92, 91, 89 and 88 for fresh Labneh in the treatments C, T1, T2 and T3 respectively, whereas those of 1 week old Labneh were 93, 93, 88 and 86 in 2 weeks old Labneh were 88, 88, 85 and 82 , in 3 weeks old Labneh were 82, 81, 79 and 78 in the treatments C, T1, T2 and T3 respectively.

As shown in Figure 10, as Appearance of fresh Labneh samples of the treatments (C and T1) contained the highest value in fresh, after 1,2 and 3 weeks old Labneh respectively, while the (T3) contained the lowest value in fresh, after 1, 2 and 3 weeks old Labneh respectively. The present results agree with those given by, who gave fewer score for appearance, consistency and flavour of Labneh supplemented with date powder prepared from different cultivars [26]. The lactic acid bacteria were very important to get good acceptability of fermented products and bio yoghurt aroma. Using 1 % of JATP had the highest scores between all treatments, this result was in line with the results mentioned by [7, 8].

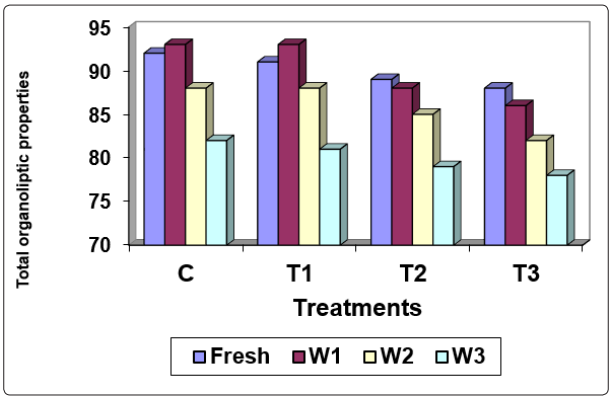

Figure 10: Total organoleptic properties of Labneh affected by effect of using JAT powder and probiotic strain

Conclusion

The present study increased the knowledge about the bio-Labneh. In conclusion, the present study was planned to develop a new type of bio- Labneh from cow's milk which is high in nutritive and healthy content fortified with different levels of JAT powder using probiotic strain. Using JATP in manufacturing bio-Labneh had acceptable. Also, it could be conducted that using JATP can be considered a good source of carbohydrates and many nutrients for the growth of *Lactobacillus acidophilus* LA-5.

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