Physicochemical and sensory properties of low-energy Labneh produced by adding oat beta-glucan

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Abstract

This study was conducted to demonstrate the effect of using oat beta-glucan as a fat replacer on the physicochemical and sensory properties of low-energy Labneh manufactured from skimmed milk by adding beta-glucan in different proportions to skimmed milk, namely 0.1, 0.2, 0.3 and 0.4%, represented by treatments L1, L2, L3 and L4, respectively, in addition to the positive control treatment C+, which was made from whole milk and the control treatment C-, which was made from skimmed milk without adding beta-glucan. chemical tests, which included estimating the percentages of moisture, protein, fat, carbohydrates, ash, and the percentages of total acidity and pH and the physical tests viscosity and hardness, in addition to the sensory evaluation immediately after manufacturing and during storage at (5±1) $_{o}$C for 21 days, were shown fat-free labneh treatments showed an increase in moisture content compared to the positive control treatment C+, while the control treatment C- had the highest moisture content among all treatments, while a decrease in moisture values was observed for all at the end of the storage period. The fat percentage decreased significantly in Labneh made from skimmed milk for all treatments compared to the positive control treatment, while its percentage increased at the end of the storage period for all treatments. The protein percentage was close in the treatments to which beta-glucan was added compared to the positive and negative control treatments, while there was an increase in the protein percentage with the advancement of the storage period for all treatments. As for the carbohydrate percentage, it was also close in the treatments to which beta-glucan was added and its value increased compared to C+ and C- treatments , noting its decrease at the end of the storage period. As for the total acidity, its percentage increased with the advancement of the storage period, and in contrast, the pH values of the adding treatments decreased. The addition of beta-glucan also improved the rheological properties of labneh , represented by viscosity and hardness, and contributed to improving the sensory properties of fat-free Labneh, especially the treatment with an addition ratio of 0.4% beta-glucan .

Keywords :
Beta-glucan, Labneh ,Oat ,sensory properties

Introduction

Fat is one of the causes of obesity, the risk of which has become increasing not only in Western countries, but in most countries of the world, and which can only be controlled

ISSN 2072-3857

through low-calorie diets, which have a positive impact on the health of the consumer (14)In addition, dietary fat is one of the most energy-dense nutrients, as it causes less satiety than carbohydrates or proteins. In addition, it has been observed that eating a high-fat diet for long periods leads to hyperphagia, increased body weight, fat deposition, and increased levels of glucose, insulin, and triglyceride (TAG). (46), (57(

Fat is characterized by its essential role in food, as it contributes mainly to highlighting the quality of texture, flavor, texture, and cohesion. Studies indicate that removing fat from dairy products negatively affects the quality of texture and texture, and in such cases the problem of texture deterioration emerges. (35) Fat greatly affects the quality indicators of food products, so reducing its content or Excluding them from the composition of food products inevitably leads to a deterioration in their quality, and this in itself is a major challenge for food producers (38). Therefore, researchers have turned to adding some materials as alternatives to fats, as these materials work to improve the rheological properties of food products, as they have a chemical composition that differs from the chemical composition of fats, but they have physical properties similar to those found in fats, so when added to food products, they give a soft texture and a creamy taste in the mouth, in addition to the viscosity that suits the type of manufactured product, and fat alternatives are either from a carbohydrate source such as beta-glucan, inulin, and microcrystalline cellulose, or from a protein source such as sodium caseinate and whey protein concentrates, or from a fatty source, such as olestra (24). The use of dietary fibers, including beta-glucan, which is characterized by its high ability to act as prebiotic stimulants, and in reducing cholesterol and blood sugar, and increasing the body's immunity, in addition to its effects in reducing weight, and also works to reduce the risk of cancer, as alternatives to fats in some food products (11). There is a great trend in using fat substitutes in the dairy industry, due to their interesting good sensory properties, due to their functional properties as well as their nutritional properties, and some of them contain high levels of biologically active compounds, in addition to their effective role in reducing energy, and obtaining healthy products that play a role in reducing energy and cholesterol and enhancing the immune system (67). This study aimed to produce a low-calorie functional labneh using skim milk and a fat replacer represented by beta-glucan extracted from oats and to study the physicochemical and sensory properties of Labneh produced immediately after manufacturing and during storage at a temperature of (5 ± 1) C for 21 days.

Materials and methods

Preparing milk

A quantity of raw mixed cow's milk (bulk milk) was prepared from the dairy laboratory - College of Agriculture - University of Anbar.

Labneh manufacturing

Labneh was manufactured in the traditional way and as described by (51) with some modifications, after obtaining a quantity of raw cow's milk, a part of it was isolated without any treatment and used in manufacturing labneh positive control treatment C+, after the percentage of total solids was adjusted to 14% using reconstituted skimmed milk , and the remaining part was subjected to a screening process with a recovery ratio of 9:1 . it became recovered milk with this ratio and was divided into two parts, the first part was left without any

ISSN 2072-3857

addition and was considered a negative control treatment C- and the other part was divided into 4 parts representing Labneh treatments to which beta-glucan was added in different proportions,

The treatments were exposed to a heat treatment of 90°C for 10 minutes and then cooled to a temperature of 42°C, and then beta-glucan was added to them in proportions of 0.1), 0.2, 0.3, (0.4%), prepared for the manufacture of Labneh for treatments (L1, L2, L3, (L4 respectively, Then the starter was added at a rate of 3%, then the incubation process was carried out at a temperature of 42 °C until the coagulation process was completed, and for a period of approximately 3 hours until the pH reached 4.6, then it was removed from the incubator, and kept at cold storage at (5±1) °C, then the process of draining the whey (whey) was conducted in cloth bags at a temperature of 5 °C for 12 hours, and after obtaining the Labneh, it was exposed inside an air oven at a temperature of about 45 °C with an air current to get rid of the largest possible amount of whey, then it was filled in tightly sealed plastic cups and each treatment separately and marked with the name and number of the treatment, and placed in refrigerated incubators at (5 ± 1) °C until the necessary tests were carried out after (1, 7, 14, 21) days of storage, as for the positive and negative treatments, they were manufactured in the same way, but without adding beta-glucan .

Chemical analysis-:

The percentage of fatwas estimated according to Kerber's method as stated in (33), while the percentage of moisture, total protein and ash was estimated according to the method followed in (7), the percentage of carbohydrates was estimated by the difference method as stated in (28) , Carbohydrates% = 100- (moisture + protein + fat + ash)%. The pH was estimated using a pH-meter, model 211, type HANNA Instruments Microprocessor, Romanian origin, while the percentage of total acidity based on lactic acid was calculated as stated in (3.(

Physical and rheological tests-:

Viscosity -:

The apparent viscosity was estimated according to the method (17). By taking samples of the labneh after 1, 7, 14, 21 days of refrigerated storage at a temperature of 10°C using the Myr-VR3000 Viscometer equipped by the company, Myr-VR3000 Engineering Lab Inc. Stoughton, Mass.), and the reading was taken twice, and according to the average in centipoise units.

Hardness -:

Texture Profile Analysis (TPA) is a British-made Stable Micro Systems group, one of the very important tests for determining the properties of the food material. This program allows for the automatic calculation of the hardness in the sample. According to the method described by (15). It is measured by placing a specific weight on the sample in weight units, net/m2 or g/mm.

Microbiological analysis-:

The total number of S.thermophilus bacteria was estimated using a sterile 1% peptone water solution and by pouring on S.thermophilus isolation agar medium. The plates were incubated under anaerobic conditions at a temperature of 42-45 °C for 48 hours, and the number of growing colonies was calculated using a colony counting device as stated in (16). The total number of L.bulgaricus bacteria was estimated using the pouring method on MRS agar medium with a pH = 4.5. The plates were incubated under anaerobic conditions, at a temperature of 42-45 °C for 72 hours, according to method (18).

ISSN 2072-3857

Then, the number of growing colonies was calculated using a colony counting device. The total number of coliform bacteria was estimated using MacConkey agar and the plates were incubated at a temperature of 37 °C for 24-48 hours, according to the method described by (8). The number of molds and yeasts was estimated using the nutritional medium Potato dextrose agar and the incubation process was conducted at 22 °C for 5 days, according to the method mentioned by (8).Psychrophilic bacteria were estimated using Nutrient agar medium, where incubation was at 7 + 1 C for 10 days, according to the method mentioned by (8.(

Sensory evaluation-:

The sensory properties of Labneh were evaluated by ten members of the teaching staff and graduate students in the Department of Food Sciences - College of Agriculture - of Anbar, they have experience and practice. The recorded values were for taste and flavor (60 points), texture and consistency (30 points) and appearance (10 points) according to the method described by (55.(

Statistical analysis-:

The statistical program SPSS (61) was used to analyze the data to study the effect of different factors (treatment and storage period/Labneh age) (the first mathematical model bi-interaction) on the studied characteristics and the effect of treatment only on other characteristics (the second mathematical model One way), according to a completely randomized design (CRD), and the significant differences between the averages were compared by the least significant difference test Significant (Least significant difference-LSD), at a probability level of 0.05.

Results and Discussion-:

Chemical traits

Total acidity and pH-:

The results obtained in Table (1) showed that the acidity values calculated as lactic acid Labneh for the different treatments immediately after manufacturing for treatments C+ and C- were 0.90

and 1.00% 1.00% respectively, and for (L1, L2, L3, L4)treatments to which beta-glucan was added, they were 0.93, 0.93, 0.94, 0.94% respectively, as the results of the statistical analysis showed no significant differences between Labneh treatments on the first day of manufacturing, while Labneh acidity increased during the 21-day storage period, as it was for the positive and negative control treatments reached 1.12 and 1.27%respectively,while for treatments to they were (1.14, 1.16, 1.17 ,1.18)% respectively , which is consistent with (54), (2), (49) and (34). Noting that there were no significant differences between the treatments at the end of the storage period, while the pH values took an opposite direction with the acidity ratio, as the pH decreased with the advancement of the storage period, and the results are consistent with (47), and that this decrease in the pH value may be due to the consumption of lactose sugar by microorganisms producing lactic acid (60), and the results of the statistical analysis indicated that there were no significant differences between the different Labneh treatments during the storage period of 21 days

ISSN 2072-3857

Table (1) Physical properties of Labneh control treatments C+ and C- and treatments to which beta-glucan was added in different proportions after manufacturing and during storage at a temperature of (5±1) for 21 days.

Treatment		Age of Labneh (day)	pH	Acidity(%)
Labneh Positive Control C+		1	4.60	0.90
		7	4.53	0.98
		14	4.42	1.08
		21	4.31	1.12
Labneh Negative Control C-		1	4.50	1.00
		7	4.48	1.08
		14	4.38	1.18
		21	4.32	1.27
Labneh Treatment with Beta-Glucan	L1 0.1%	1	4.58	0.93
		7	4.43	0.99
		14	4.37	1.07
		21	4.28	1.14
	L2 0.2%	1	4.57	0.93
		7	4.50	0.97
		14	4.40	1.08
		21	4.30	1.16
	L3 0.3%	1	4.57	0.94
		7	4.48	1.00
		14	4.37	1.09
		21	4.28	1.17
	L4 0.4%	1	4.56	0.94
		7	4.42	1.02
		14	4.31	1.11
		21	4.25	1.18
L.S.D			0.471 NS	0.445 NS
* (P≤0.05), NS: not significant.				

Moisture percentage-:

Table (2) shows the percentage of moisture, where its value for the positive control treatment Reached for C+ and C- immediately after manufacturing 68.22 and 71.14%, respectively. This result is consistent with what was reached by (1), who stated that the moisture percentage for the positive treatment was 68.57 when manufacturing Labneh from whole milk. It is also noted that the moisture percentage is higher in the C- treatment compared to the positive treatment labneh C+. This is consistent with (22). The reason for the high moisture percentage for the negative control treatment may be due to the decrease in the percentage of total solids as a

ISSN 2072-3857

result of not adding beta-glucan to it compared to the addition treatments, As for the moisture percentage for Labneh treatments to which beta-glucan was added immediately after manufacturing, it reached (69.92, 69.88, 69.84, (69.82%), respectively. These results are consistent with (50), who stated that the moisture percentage of addition treatments is less than the negative treatment C-, a decrease in the percentage of moisture was observed during the storage period and for all treatments, as the values after 21 days for treatment C+ and C- were 67.97 and 69.80% respectively, and for the Labneh treatments added with beta-glucan 69.60, 69.58, 69.54 and 69.53% respectively, and this result is consistent with (22), and the reason for the decrease in moisture content at the end of the storage period is due to natural evaporation (56), (4), (58), (59). The increase in total solids as a result of adding beta-glucan, compared to the negative low-fat treatment, as the lowest value of moisture content was in the fourth treatment (0.4% beta-glucan) which reached 69.03%, and this is consistent with what was indicated by (64). The results of the statistical analysis showed significant differences ($P > 0.05$) in moisture content between all treatments during the 21-day storage period .

Fat percentage -:

Table (2) shows the percentage of fat in the labneh of the different treatments mentioned, where immediately after manufacturing Labneh treatment C+ and C- were 9.74 and 3.2% respectively. It is noted that the percentage of fat in Labneh treatment C- was very low compared to Labneh treatment C+, and the reason for this is that the labneh of this treatment was made from skimmed milk. As for the percentage of fat in the labneh of the treatments to which beta-glucan was added immediately after manufacturing, it reached 30.2, 20.2, 2.10, 2.00% respectively. It is noted that there is a slight decrease in the percentage of fat in the treatments to which beta-glucan was added compared to the control treatment C- due to the increase in the concentration of solids after adding the beta-glucan fat treatments fat replacer to the labneh of the fat-free treatments, while an increase in the percentage of fat was observed in all treatments during storage, as after 21 days Labneh treatment C+ and C- were 9.93% and 3.4% respectively. The labneh treatments to which beta-glucan was added were 2.50, 2.40, 2.30, 2.30% respectively. The reason for this is the decrease in the moisture content during storage, which led to an increase in the percentage of total solids including fat. The results agree with what was found by (32), (9) and (6) who indicated that the increase in the percentage of fat in all Labneh treatments during the storage period was due to the loss of moisture, and thus increased the percentage of total solids including the percentage of fat. The results of the statistical analysis indicate the presence of significant differences ($P<0.05$) between the labneh treatment C+ and the labneh of all treatments free of fat on the first day after manufacturing as well as the end of the storage period of 21 days.

ISSN 2072-3857

Table (2): Chemical analysis of Labneh control treatment C+ and C- and low-fat labneh treatments to which different proportions of beta-glucan were added after manufacturing and during storage at a temperature of (5±1) C for 21 days.

Treatment		Labneh's age (day)	Moisture %	Protein %	Fat %	Ash %	Carbohydrates %
Labneh Positive Control C+		1	68.22	8.64	9.74	0.87	12.53
		7	68.11	8.68	9.80	0.89	12.52
		14	68.04	8.72	9.85	0.90	12.49
		21	67.97	8.76	9.93	0.92	12.42
Labneh Negative Control C⁻		1	71.14	8.83	3.20	0.98	15.85
		7	71.10	8.88	3.20	0.99	15.83
		14	69.95	8.92	3.30	1.02	15.81
		21	69.80	8.98	3.40	1.02	15.80
Labneh Treatments with beta-glucan added	L1 0.1%	1	69.92	8.72	2.30	0.99	18.07
		7	69.88	8.77	2.30	1.00	18.05
		14	69.75	8.81	2.40	1.01	18.03
		21	69.60	8.86	2.50	1.02	18.02
	L2 %0.2	1	69.88	8.71	2.20	1.00	18.21
		7	69.80	8.81	2.20	1.00	18.19
		14	69.69	8.82	2.30	1.01	18.18
		21	69.58	8.84	2.40	1.02	18.16
	L3 0.3%	1	69.84	8.70	2.10	1.01	18.35
		7	69.81	8.74	2.10	1.01	18.34
		14	69.66	8.79	2.20	1.02	18.33
		21	69.54	8.81	2.30	1.03	18.32
	L4 0.4%	1	69.82	8.70	2.00	1.01	18.47
		7	69.78	8.75	2.10	1.02	18.35
		14	69.65	8.78	2.20	1.03	18.34
		21	69.53	8.81	2.30	1.04	18.32
L.S.D			2.084 *	0.791 NS	2.164 *	0.229 NS	4.073 *
* (P≤0.05), NS: not significant.							

*Each number in the table represents an average of three replicates

Protein-:

It is noted from Table (2) that the percentage of protein in the labneh of the control treatment C+ and C- immediately after manufacturing reached 8.64 and 8.83% respectively, and for the low-fat Labneh treatments to which beta-glucan was added it was 8.72, 8.71, 8.70, 8.70% respectively, and it is also noted that the percentage of protein increased at the end of the storage period of 21 days in the labneh of all treatments, as it was for the treatment C+ and C- 8.76 and 8.98% respectively, while for the Labneh treatments

ISSN 2072-3857

to which beta-glucan was added it was 8.86, 8.84, 8.81, 8.81% respectively, this result is consistent with what was found by (22) who indicated an increase in the percentage of protein in the Labneh treatments to which beta-glucan was added from 8.84% after Directly manufactured to 8.99% at the end of the 20-day storage period. The reason for the high protein content is the decrease in moisture content and thus the increase in the percentage of total solids including protein. The results of the statistical analysis indicate that there are no significant differences (P<0.05) in the percentage of protein between the different Labneh treatments immediately after manufacturing and during the storage period at a temperature of (5 ± 1) C for 21 days.

Ash percentage-:

Table (2) shows the results of the ash percentage in the different Labneh treatments mentioned previously, where this percentage was immediately after manufacturing for the C+ and C- treatments, which amounted to 0.87 and 0.98%, which is consistent with what was found by (50), who estimated the ash percentage in Labneh manufactured from cow's milk, which was 0.89%. It is noted that the ash percentage is higher in the negative treatment C- brick compared to the positive treatment C+ brick, and the reason is that the milk used in manufacturing Labneh in this treatment is skim milk, which contains higher protein and higher moisture content, and may cause an increase in the amount of dissolved mineral salts, which leads to an increase in ash compared to the positive treatment (36). As for the ash percentage of Labneh treatments to which beta-glucan was added, it was 0.99, 1.00, 1.01, 1.01%, respectively. It is noted that the ash percentage increased slightly with the addition of the beta-glucan fat replacer .This may be due to the fact that beta-glucan is a rich source of vitamins and minerals such as potassium, calcium, phosphorus, magnesium, iron, zinc, and copper (52)) and (44). Labneh is also considered a rich source of most of the minerals mentioned, and at a higher percentage than the content of the milk from which it was made (45). The table also shows an increase in ash percentages for all treatments during the 21-day storage period. The control treatment C+ and C- was 0.92 and 1.02%, respectively, and Labneh treatments with beta-glucan added were 1.02, 1.02, 1.03, and 1.04%, respectively. The increase may be due to an increase in the total solids content during the storage period, which is consistent with what was found by (9), (19). The results of the statistical analysis indicate that there are no significant differences between Labneh treatments, but significant differences appeared within the same treatment, which is consistent with what was found by (12), (25), (63 .(

Carbohydrate percentage -:

Table (2) shows the percentages of carbohydrates in the brick of the different treatments mentioned above, where its percentage immediately after manufacturing labneh treatment C+ and negative C- was 12.53 and 15.85% respectively, while the brick of the treatments to which beta-glucan was added was 18.07, 18.21, 18.35, 18.47% respectively. It is noted that the percentage of carbohydrates is higher in the brick of the treatments to which beta-glucan was added, and the reason for this is that beta-glucan is a carbohydrate substance, so when added, it led to an increase in the percentage of carbohydrates. It is noted from the results of the statistical analysis that there are significant differences between the positive control treatment and all other treatments immediately

ISSN 2072-3857

after manufacturing. It is also noted that there is a decrease in the percentage of carbohydrates with the progress of the storage period for all treatments, as after 21 days of storage, Labneh treatment C+ and C- reached 12.42, 15.80% respectively, while for Labneh treatments added to beta-glucan, it was 18.02, 18.16, 18.32, 18.32% respectively. This decrease may be due to the activity of microorganisms that ferment some carbohydrates and convert lactose sugar into lactic acid (23.(

Table (3) Rheological properties of Labneh treatment C+ and C- and Labneh treatments added to beta-glucan on the first day after manufacturing and the end of the storage period of 21 days at a temperature of (5±1) °C

Treatment		Labneh's age (day)	Hardness Net/m2	Viscosity Centipoise
Labneh Positive Control C^+		1	124	1670
		21	309	2118
Labneh Negative Control C^-		1	205	1420
		21	310	1860
Treatments Labneh with beta-glucan added	L1 0.1%	1	127	1715
		21	232	2115
	L2 0.2%	1	118	1730
		21	223	2110
	L3 0.3%	1	114	1735
		21	219	1890
	L4 0.4%	1	106	1765
		21	211	1865
L.S.D			22.703 *	136.844 *
) *P≤0.05.(				

*Each number in the table represents an average of three replicates

Rheological properties-:

Viscosity-:

Table (3) shows the viscosity values for the different treatments, Were reached for treatment C+ and C- immediately after manufacturing 1670 and 1420 centipoise, respectively, where significant differences are observed between treatments C+ and C-, and the reason for the decrease in its value in the negative control treatment is that removing the fat leads to a decrease in viscosity as well as an increase in its moisture content.

This is consistent with what was reached by (41), who indicated that viscosity increases with increasing concentration of both fat and protein. As for the viscosity values of the Labneh treatments to which the beta-glucan fat substitute was added, they reached 1715, 1730, 1735, and 1765 centipoise, respectively. It is clear that the viscosity values increased

ISSN 2072-3857

with increasing the added percentage of the beta-glucan as a fat replacer , as it is noted that the treatments to which the beta-glucan fat substitute was added outperformed the rest of the treatments. This is consistent with (40), who indicated that beta-glucan is used as a fat substitute due to its properties such as gelation and viscosity. It also agrees with what was found by (62) who indicated an increase in the viscosity values of Labneh treatments to which the fat substitute was added, compared to the positive and negative control treatments. As for the viscosity values of Labneh treatments at the end of the 21-day storage period, they were for the positive treatments C+ and C- 2118 and 1860 centipoise, respectively. This agrees with what was found by (29) who indicated that the viscosity of the positive and negative control labneh treatments increased after the end of the 21-day storage period. The reason may be due to the decrease in the pH Labneh, which leads to an increase in its hardness, and thus an increase in its viscosity (68). The viscosity values of the Labneh treatments to which the beta-glucan fat substitute was added reached 2115, 2110, 1890 and 1865 centipoise respectively. This is consistent with (10), which indicated an increase in viscosity for all treatments at the end of the storage period. The reason for this is the presence of polysaccharides, which interfere with the protein content of Labneh, leading to an increase in its viscosity. The results of the statistical analysis indicate that there are significant differences ($P<0.05$) in the viscosity values immediately after manufacturing as well as after the storage period of 21 days, between the control treatments C+ and C- and the treatment to which the beta-glucan fat substitute was added at a rate of 0.4%.

Hardness - :

Table (3) shows the results of the hardness test immediately after manufacturing and during storage at a temperature of (5±1) C for 21 days for each of the control treatment bricks C+ and - C and the treatment bricks to which the beta-glucan fat substitute was added, as it is noted that the hardness of the positive treatment bricks C+ and C- on the first day of manufacturing reached 124 and 205 N/m2, respectively, which represents the amount of force required to compress the Labneh sample, while the treatments to which the beta-glucan fat substitute was added had hardnesses of 127, 118, 114 and 106 N/m2 for treatments L1 and L2 L3 and L4 respectively, It is noted that the treatments added to the fat substitute had a hardness close to the hardness of treatment C+ and less than the hardness of treatment C-, which is consistent with what was found by (22), (58) who indicated a higher hardness of Labneh C- manufactured from skimmed milk compared to Labneh manufactured from whole milk C+, and the other replacement treatments when Labneh is manufactured from cow's milk, which confirms the role of these additives in improving the texture of Labneh through the ability of oat beta-glucan to bind water and thus reduce hardness, the results are consistent with what was reached by (65) who indicated the ability of beta-glucan to bind water and its structural ability. The reason for the high hardness values for the negative treatment of the Labneh brick treatment C- is due to the increase in the total protein content of this treatment compared to other treatments (21) (53), (48) who stated that the rheological behavior of Labneh depends on the protein concentration. It is also noted that the hardness of the brick of all treatments increased at the end of the storage period of 21 days, as its value for treatment C+ and C- reached 209 and 310 nt/m2, respectively, while for the additional treatments it reached 232, 223, 219 and 211 nt/m2, respectively. These results are consistent with what was reached by (29), who indicated the increase in hardness values at the end of the storage period for most of the Labneh treatments that were manufactured. The reason for this is due to the increase in the content of total solids and total protein for all manufactured Labneh treatments (5), (21), (27), (42) and (37.(

Microbiological tests-:

It is noted from the results of Table (4) that the number of bacteria increased .The total and all labneh treatments, where it reached the maximum on the seventh day of the storage period, then began to decrease with the progress of the storage period, and the reason for this may be due to the effect of refrigerated storage or advanced acidity, and these results agree with the results of (26), (20), (13) and (69) who indicated that the total number of bacteria gradually increased during the storage period to reach the highest level on the fourteenth day, then decreased with the progress of the storage period, which may be due to the effect of advanced acidity. It also agrees with what was reached by (66) who indicated that all Labneh transactions showed an increase in the total number of bacteria, streptococci and lactobacilli, and this increase may be due to the stimulating effect of oat beta-glucan, which acts as a prebiotic and enhances the growth of lactic acid bacteria. It is also noted from the results that all labneh treatments are free of coliform bacteria and cold-loving bacteria, whether when fresh or during storage periods at a temperature of (5±1). The results are consistent with what was reached by (50) during the manufacture of low-fat labneh using the fat substitute barley beta-glucan, which indicated that all fresh, stored and processed labneh treatments were free of coliform bacteria due to the high heat treatment and sanitary and clean conditions during the manufacturing and storage process.

ISSN 2072-3857

Table (4): Microbiological analysis of Labneh positive treatment C+ and C- and Labneh treatments with added fat substitute beta-glucan after manufacturing and during storage at a temperature of (5±1) for a period of 21 days

Treatment		Labneh's age (day)	Total number of starter bacteria CFU/g	Number of hygrophilous bacteria CFU/g	Number of coliform bacteria CUF/g	Number of molds and yeasts
Labneh Positive Control C+		1	10^7 X72	0	0	0
		7	10^7 X 83	0	0	0
		14	10^7 X 65	0	0	0
		21	10^7 X 42	0	0	0
Labneh Negative Control C-		1	10^7X 88	0	0	0
		7	10^7X 94	0	0	0
		14	10^7X 83	0	0	0
		21	10^7X 54	0	0	0
Treatments Labneh with beta-glucan added	L1 0.1%	1	10^7X 74	0	0	0
		7	10^7X 90	0	0	0
		14	10^7X 79	0	0	0
		21	10^7X 43	0	0	0
	L2 0.2%	1	10^7X 75	0	0	0
		7	10^7X 88	0	0	0
		14	10^7X 77	0	0	0
		21	10^7X 44	0	0	0
	L3 0.3%	1	10^7X 75	0	0	0
		7	10^7X 89	0	0	0
		14	10^7X 78	0	0	0
		21	10^7X 44	0	0	0
	L4 0.4%	1	10^7X 76	0	0	0
		7	10^7X 83	0	0	0
		14	10^7X 74	0	0	0
		21	10^7X 45	0	0	0
L.S.D			12.805 *	0.00 NS	0.00 NS	0.00 NS
* (P≤0.05), NS: not significant.						

*Each number in the table represents an average of three replicates

Sensory evaluation-:

It is noted from the results of Table (5) that the positive treatment Labneh C+ was superior to the negative treatment Labneh C- low fat in all sensory evaluation characteristics under study. The reason for this is due to the effective role of fat in imparting the characteristics of taste, flavor, texture, consistency and good and desirable appearance. The results are consistent with what was found by (39), (50) and (43) who indicated that the positive control treatment C+ Labneh manufactured from whole milk was superior in sensory evaluation immediately after manufacturing to

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the negative control treatment C manufactured from skimmed milk.

Table (5) Sensory evaluation of Labneh control treatment C+ and C- and low-fat labneh treatments to which the fat substitute beta-glucan was added in different proportions during storage at a temperature of (5±1) C for 21 days.

Treatment		Labneh age (day)	Taste and flavor 60	Texture and texture 30	Appearance 10	Total score out of 100
Labneh Positive Control C+		1	57	28	9	94
		7	55	26	9	89
		14	54	23	8	85
		21	54	21	7	82
Labneh Negative Control C-		1	50	22	9	81
		7	50	21	8	79
		14	48	20	7	75
		21	47	19	7	73
Treatments Labneh with beta-glucan added	L1 0.1%	1	52	24	9	85
		7	52	23	9	84
		14	51	22	8	81
		21	49	21	8	78
	L2 %0.2	1	53	25	9	87
		7	52	24	9	85
		14	51	23	9	83
		21	50	22	8	80
	L3 0.3%	1	55	26	9	90
		7	54	25	9	88
		14	53	24	9	86
		21	52	23	8	83
	L4 0.4%	1	57	27	9	93
		7	57	26	9	92
		14	56	25	9	90
		21	55	24	8	87
L.S.D			4.618 *	3.255 *	1.420 *	8.826 *
) *P≤0.05.(						

*Each number in the table represents an average of three replicates.

It is also noted that the positive treatment C+ outperformed the Labneh treatments to which beta-glucan was added immediately after manufacturing, mentioned above, which amounted to 85, 87, 90, and 93 out of 100 points, respectively. On the other hand, it was noted that the treatments to which beta-glucan was added obtained higher sensory evaluation scores compared to treatment C-, which confirms the effective role of beta-glucan in maintaining the sensory properties Labneh in a

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manner directly proportional to the increase in the added percentage, reaching the labneh of treatment L4 with a percentage of 0.4% beta-glucan, at which most of the sensory properties are very close to the labneh of the positive treatment C+, and this is consistent with what was mentioned by (31) that beta-glucan is characterized by its ability to change the functional and rheological properties such as viscosity, sensory properties and texture when combined or added to the food product, and it also works to improve the flavor and texture of dairy products. At the end of the storage period, the sensory evaluation scores for the Labneh C+ and C- treatments were 82 and 73 respectively, while for the Labneh treatments to which beta-glucan was added, they were 78, 80, 83 and 87 respectively. It is noted that the sensory evaluation scores decreased for all treatments at the end of the 21-day storage period. This is consistent with what was reached by (30), who indicated a decrease in the sensory evaluation scores for Labneh supplemented with mushroom powder and for all treatments at the end of the 28-day storage period. It is noted from the results that the labneh L4 treatment to which beta-glucan was added by 0.4% outperformed all Labneh treatments to which beta-glucan was added, as it obtained the highest sensory evaluation scores granted after the end of the 21-day storage period. It is also noted that the negative control treatment obtained the lowest sensory evaluation scores compared to all the different Labneh treatments. The results of the statistical analysis indicate that there are significant differences ($P<0.05$) between the negative treatment C- and the other treatments, and it is also noted that there are significant differences between the different time periods within the same treatment in the sensory evaluation scores.

Conclusions- :

Beta-glucan is a good source of carbohydrates, vitamins and minerals, and due to its possession of many physical and rheological properties, it has become possible to make good quality labneh by adding up to 0.4% of beta-glucan without negatively affecting the quality of the labneh.

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