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The Manufacture of Low Fat Labneh Containing Barley β-Glucan 1-Chemical Composition, Microbiological Evaluation and Sensory Properties

[1]R. Elsanhoty, [2]A. Zaghlol and [3]A.H. Hassanein
[1]Department of Industrial Biotechnology,
Institute of Genetic Engineering and Biotechnology,
Branch of Food and Dairy Biotechnology, Menufia University, Egypt
[2]Department of Dairy Science, National Research Center, Egypt
[3]Department of Dairy Science, Food Technology Research Institute,
Agricultural Research Center, Egypt

Abstract: In this study, the influence of addition of barley β-glucan on the basic characteristics (chemical, microbiological and sensory attribute) of low fat content labneh cheese during a storage period of 30 days at 5°C were investigated. Low fat labneh cheese was manufactured by traditional methods from cows milk at the different fat reduction [25% (Exp. 1), 50% (Exp. 2) and 75% (Exp. 3)] containing 5% (w/w) barley β-glucan as fat replacer. For comparison two control samples were manufactured full fat milk (C1) and 0.1 fat milk without barley β-glucan (C2). Two strains of probiotic bacteria (*Lactobacillus acidophilus* LA-5 and *Bifidobacteria lactis* Bb12) were used as starter culture. The results obtained in this investigation revealed that the addition of barley β-glucan showed quite a remarkable degree in improved the probiotic viability during storage period, in comparison to the controls samples. A striking featured of the results is that all treatments investigated show an agreeable microbiological quality. In addition, the sensory panel indicated that the most acceptable labneh is that containing 5% barley β-glucan and fat content reduced to 50 and 25% were highly acceptable than that containing 5% barley β-glucan and fat content reduced to 75%. The least acceptable sample was that made of fat content in milk reduced to 0.1% without barley β-glucan. As the fat content of labneh milk is decreased, the moisture total protein and ash values were increased. The products that fortified with barley β-glucan were exhibited higher yield and lower pH value during storage period than the control samples. The addition of barley β-glucan to labneh with probiotic bacteria could be considered as a raw material for production of polyfunctional nutrition.

Key words: Low fat, barley β-glucan, probiotic bacteria, functional foods

INTRODUCTION

During the last two decades people began to be more aware of the close relationship between diet and health. This awareness dictated great interest in seeking elegant methods for improving food industry. Thus different types of nutraceuticals were introduced in this field such as Soluble Dietary Fibers (SDF) which have been thought to have a great role in health promotion and disease prevention (Behall *et al*., 2006). Attention has recently been focused on the potential use of β-glucan from barley and other cereals as a functional food ingredient (Malkki, 2004; Trepel, 2004).

One SDF, which has attracted considerable interest, is barley β-glucan. The incorporation of β-glucan into low fat cheese products has been investigated. Tudorica *et al*. (2002) explored the

Corresponding Author: R. Elsanhoty, Department of Industrial Biotechnology, Institute of Genetic Engineering and Biotechnology, Branch of Food and Dairy Biotechnology, Menufia University, Egypt Tel: 0020102248605

effect of fibre inclusion on curd formation and also showed that increasing levels of β-glucan resulted in decreased gel times and increased curd yields. Konuklar *et al*. (2004) manufactured a low-fat cheddar cheese and concluded that β-glucan had the potential to act as a nutraceutical fat replacer and also to increase moisture and salt retention. Moreover, Tudorica *et al*. (2002) also found that the inclusion of β-glucan in low fat yoghurt resulted in a product with similar firmness to that of a full fat control. They studied the influence of dietary fibre from a number of different sources on the sensory and rheological properties of yoghurt and found that yoghurt fortified with wheat, bamboo, inulin or apple fibres did not show syneresis after 21 days of storage at 4°C. Although rheological parameters were found to vary with storage time and fibre source, sensory analysis did not detect any difference and all fortified samples were found to be acceptable (Dello Staffolo *et al*., 2004). Probiotic foods have steadily gained popularity over the past decades and a wide variety of foods are nowadays used as carriers for probiotic cultures, including fermented milk products (Coeuret *et al*., 2005), cheese (Ross *et al*., 2000), ice cream (Christiansen *et al*., 1996), fermented sausages, fruit juices (Post, 2002), infant formulas (Todd, 2003) and cereal bars (Ouwehand *et al*., 2004).

Soluble dietary fibers were shown to have remarkable effects in relation to human health situation; such diets were shown to reduced the risk of the developing cardiovascular disease because they lead to a decrease in blood cholesterol levels, decreased carbohydrate digestion and hence regulation of postprandial blood glucose and insulin level (Jenkins *et al*., 2002; Tudorica *et al*., 2002; Brennan and Tudorica, 2003; Tungland, 2003; Crittenden *et al*., 2002). Earlier research shown that dietary fibers could reduce and the promotion of a healthy balance of gut micro flora.

Although tremendous reports and researches were published in the field of the utilization of many legumes such as Soya in the manufacture of yoghurt and yoghurt like products, yet the study on the interaction of barley β-glucan and milk compounds is very scantly indeed (Shirai *et al*., 2006; Moussa and Abd El-Gawad, 2007). However, very few published reports on the preparation and quality characteristics of labneh made along with use of barley β-glucan containing scattered information are available (Volikakis *et al*., 2004). Thus, the objectives of this study are to throw more adequate light on the application of barley β-glucan in the manufacture of low fat labneh. In addition, study the effect of adding of barley β-glucan on the chemical, microbiological and sensory evaluation of low fat labneh product during storage period. The study was extended to include the study of the viability of probiotic bacteria employed in this process and the effect of the storage period.

MATERIALS AND METHODS

Materials

Cows Milk

This study was achieved at 2005/2006; cows milk was obtained from plant of Dairy Technology, Food Technology Research Institute, Agricultural Research Centre, Giza, Egypt.

Barley β-Glucan

Dried barley β-Glucan molecular weight 337 kDa was purchased from Megazyme International Ireland Ltd. (Bray, IRL) and stored at 20°C.

Bacterial Strains

Bifidobacterium lactis Bb-12, *Lactobacillus acidophilus* LA-5 (Freeze-Dried Red-Set) were obtained from Chr. Hansen Laboratories, Copenhagen, Denmark. The working culture was prepared by adding a few milligram of freeze-dried culture to 100 mL of previously reconstituted and sterile (121°C/ 2 min) skimmed milk with 10% total solids. This mixture was then incubated at 42°C until the onset of gelation. Two milliliters of culture from this passage were transferred into 100 mL of sterile

skim-milk at 42°C and once again, the culture was incubated until a gel had just formed. This second culture was used for the propagation of a bulk culture (1 L) for inoculcation of the different treatments. Bulk cultures were prepared 1 day before the production of labneh.

Methods

Preliminary Labneh Makings

Preliminary investigations were carried out in order to establish the suitable working amount of the β-glucan preparation to be added into the labneh milk. Thus two different levels of the dried barley β-glucan were added into the labneh milk at 3 and 5% (w/w) and simulation of the labneh making process was performed. Optimum amounts of β-glucan used in labneh was marked.

Manufacture of Control Labneh and Experimental Labneh

Fresh whole cows milk (75 kg) was obtained from the Food Technology Research Institute, and processed at the plant of the Department of Dairy Technology mention above. A portion of whole milk (15 kg) was kept as control and denoted as C1 and the remaining amount of milk was divided into four portions and subjected to reduction of fat to, 99.9, 75, 50 and 25% and denoted C2, Exp. 1, Exp. 2 and Exp. 3. All portions of milk were heated to 85°C for 20 min and then the portions Exp. 1, Exp. 2 and Exp. 3 were cooled to 60°C, then 5% of the barley β-glucan was incorporated into the Exp. 1, Exp. 2 and Exp. 3 vats of the low fat labneh milk by the results of this preliminary study. The incorporation of dried barley β-glucan was succeeded by its dispersion in a small portion of the pasteurized low fat cheese milk using a high speed blender until no lumps were visible. All labneh milk treatments were cooled to 40°C and inculcated with 3% from the mixture of both *Lactobacillus acidophilus* LA-5 and *Bifidobacterium lactis* Bb-12 and incubated at 42°C for 3-4 h until the pH of 4.6 was attained. The resulting yoghurt was placed in cloth bags and left to the whey at 6°C overnight. The obtained labneh was poured into plastic cups (150 g). Samples of labneh were brought to laboratory, in refrigerated trucks, within 1 to 2 h finally held at 5°C during stored period of 30 days and assessed chemically, microbiologically and organoleptically.

Experimental Design

The experimental design involved the manufacture of five different products: one control (full-fat without β-glucan), anther control (low fat (LF 0.1%, without β-glucan) and three additional low-fat treatments using β-glucan concentrate at 5% (w/w) of labneh milk. The fat reduction was (25, 50 and 75%), respectively. The whole procedure was repeated three times. Samples from each group of labneh were taken at least in duplicate for chemical and in triplicate for microbiological and sensory evaluation and labneh cans were opened at regular time intervals for sampling.

Microbiological Counts

Total bacterial counts, yeasts and molds and coliforms were enumerated according to standard procedures (Marshall, 1992), Labneh containers were wiped, from the outside, with 70% ethanol and their contents were thoroughly mixed with a sterile spatula. A composite subsample was prepared by transferring labneh into a sterile 250 mL Erlenmeyer flask, that contained sterile phosphate buffer and blending with warm buffer (40°C) until a homogeneous mixture was obtained. Total bacterial counts and coliforms were determined by the pour plate technique, while yeasts and molds were enumerated by the spread plate technique. Total bacterial counts were determined using plate count agar and incubation at 32°C for 48 h. Coliforms were enumerated on violet red bile agar after incubation at 37°C for 24 h. Yeasts and molds and were enumerated on plate count agar that contained 0.01% chloramphenicol and 0.01% chlortetracycline hydrochloride and incubation at 25°C for 5 day and 5°C for 10 day, respectively. *Bifidobacterium lactis* Bb-12 was determined in MRS-OG mixture solution

of (0.02% Oxgall and 0.03% Gentamince) according to the method described by Lim *et al*. (1995). Plates were incubated anaerobically at 37°C for 48 h. *Lactobacilus acidophilus* was determined using lactobacillus selective agar plus 0.2 Oxgell (LBSO) (Gilliland and Walker, 1990). The plates were incubated at 37°C for 4 days.

Chemical Analysis

Protein, fat, lactose and moisture of labneh were determined according to AOAC (2000). Titratable acidity was determined by titrating 10 g of sample with 0.1 N NaOH using phenolphthalein indicator. pH values of all labneh samples were recorded using digital pH meter model SA 720 (Orion, USA). Acetaldehyde was determined according to Lees and Jago (1969) using Conway microdiffusion-Semicarbazide method. Acetaldehyde reacts with the Semicarbazide to form semicarbazone which has an absorption peak at 224 nm. The procedure was as follows: one milliliter of 1 μmol Semicarbazide solution was pipetted in the inner wall of Conway micro diffusion cell. Three milliliters of sample were rapidly pipetted in the outer compartment and the cell was covered, firmly by plaster and incubated at 37°C for 90 min. The solution in the inner wall was transferred into 10 mL volumetric flask and made up to volume with distilled water. The absorption was measured at 224 nm. The earlier procedure was followed to determine diacetyl content at 270 nm. Using the same spectrophotometer as described by Lees and Jago (1976). Organic acids in labneh were determined using HPLC. LC, from Waters Associates Equipped with 600E multi solvent delivery system and millennium chromatography workstation was used. Determination was carried out at wave-length 210 nm, flow rate of 1.5 mL min^{-1} and ambient temperature Altec column (250×4.6 mm) with mobile phase 0.001% H_2SO_4. The sample (3 g) was mixed with 7 mL of buffer mobile phase, homogenized (Vortex for 1 min), extracted for 1 h and centrifuged at 7000×g for 5 min. The supernatant was filtered through 0.45 μm membrane filter (Sartorious SM 11606): 20 μL were injected with 25 μL Hamilton syringe (Hamilton Co., Reno.NV). HPLC grade reagents were used as standards (Sigma Chemicals Co., St.Louis, MO). Twenty microliters of each membrane filter (0.22 μm) filtered sample was injected and detected using waters M6k manual injector at ambient temperature equilibrated with mobile phase at flow rate of 1.5 mL min^{-1}. The absorbed organic acids (formic, pyruvic, lactic, acetic and citric) were eluted isocratically using the mobile phase 0.001 H_2SO_4 (1L MQ water added 1 mL sulfuric acid.). Five organic acids standards were dissolved in HPLC water with known concentrations and 20 μL were injected under the same condition as the sample. Organic acids were quantified by comparison of peak areas of authentic samples with those of the corresponding organic acids standard solution using the millennium Data System Program. All analysis of milk and labneh samples were done in triplicates.

Sensory Evaluation

All labneh samples were stored at 0, 4, 8, 18 and 30 days at (5 = °C ±1 and were evaluated for flavor, texture, appearance and over all acceptability by 20 staff member from both Dairy Department, Food Technology, Agricultural Research Center and Department of Food and Dairy Technology, National Research Center who familiar with labneh. Anine-point hedonic scale (Stone and Sidel, 1985) was utilized in this study (9 = like extremely, 5 = neither like nor dislike and 1 = extreme dislike).

Statistical Analysis

Statistical analysis was performed by running Student, t-test using Stat view 512 software (1986). Chi-square was performed to compare between the controls and experimental labneh. Significant effects were declared $p<0.05$.

RESULTS AND DISCUSSION

Microbiological Properties

Effect of Reduction in Fat Content of Labneh Milk Incorporation with Barley β-Glucan on the Viability of *Bif. lactis* Bb-12 (log/cfu/g) in Labneh During Storage Period 30 Days at 5°C

The effect of reduction in fat content of labneh milk and incorporation of barley β-glucan on the viability of *Bif. lactis* Bb-12 (log/cfu/g) in labneh during storage period of 30 days at 5°C is presented in Fig. 1. The data show that there was an increase in the log count of *Bif. lactis* Bb-12 in all treatment, reaching the highest count at 4 days of storage period. Thereafter, a gradual regular decreased in the count was observed for all treatments during storage period. The results are in full concord with the results obtained by Gomes and Malcate (1999) who has attributed the decrease in the viability of *Bif. lactis* Bb-12 may be due to the sensitivity of bifidobacteria to low pH arising mainly from the relatively high concentrate of lactic and acetic acids (Gomes *et al*., 1995). Moreover, the sample labneh contained 5% barley β-glucan and the fat content in milk reduced to 25% had the highest viable count than other treatments. These results are also in complete harmony with those obtained by other workers who demonstrated that addition of barley β-glucan enhanced the growth and survival of lactic acid bacteria (Jaskari *et al*., 1998). There were significant differences ($p>0.05$) between the C1 and C2 and the Exp. 1, Exp. 2 and Exp. 3 that contained 5% barley β-glucan. The obtained results were similar to results that were obtained by Mousa and Abd El-Gawad (2007) who reported that the incorporation of synbiotics (Dairy-Lo and 0.1 Dairy Loid) improved the growth and survival of probiotic bacteria in labneh. Generally, there were better growth and survival of probiotic bacteria in the products supplemented with barley β-glucan. A further support is obtained from similar findings of other researchers who reported that the bifidbacterium are relatively sensitive to low pH and the results are also in agreement with Chou and Hou (2002) and Laine *et al*. (2003), who reported that the bifidbacterium can grow and reduce the pH of oat-based medium.

Effect of Reduction in Fat Content of Labneh Milk Incorporation of Barley β-Glucan on the Viability of *lactobacillus acidophilus* LA-5 (log/cfu/g) on Labneh During Storage Period 30 Days at 5°C

Figure 2 shows quite clearly that the log count of treatment in Exp. 1 in which fat content was reduced to 25 and 50% was higher than the log content of other treatments. There were significant differences ($p<0.05$) between the C1, C2 and the Exp. 1, Exp. 2 and Exp. 3 containing on 5% barley β-glucan. Thus the extended viability of the organism under these two conditions during storage period especially the treatments of the controls C1 and C2. Similar results were reported by other researchers working in this field concerning the viability and survival of *Lactobacillus acidophilus* in oat mash (Bekers *et al*., 2001; Charalampopoulos *et al*., 2002).

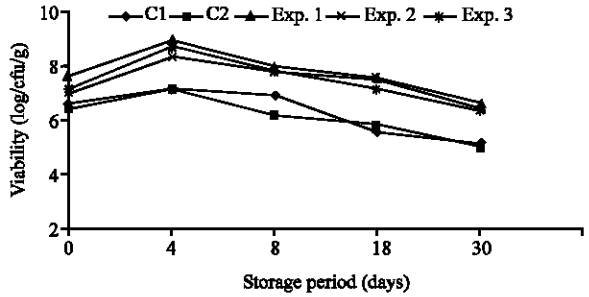

Fig. 1: Effect of reduction in fat content of labneh milk incorporation of barley β-glucan on the viability of *Bif. lactis* Bb-12 (log/cfu/g) in labneh during the storage period 30 days

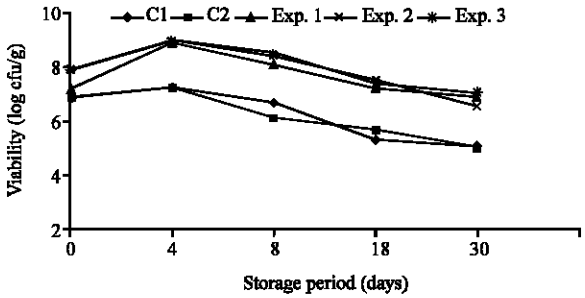

Fig. 2: Effect of reduction in fat content of labneh milk incorporation of barley β-glucan on the viability of *Lb. acidophilus* LA-5 (log/cfu/g) in labneh during the storage period 30 days at 5°C

Table 1: Yeast and mould of labneh-like product from probiotic fermented barley during the storage period of 30 days at 5°C

	Storage period (days)				
Treatments	Fresh	4	8	18	30
C1	0	0	2.00	3.40	6.30
C2	0	0	2.97	4.10	5.90
Exp. 1	0	0	2.30	3.91	5.63
Exp. 2	0	0	2.70	4.50	6.30
Exp. 3	0	0	3.10	4.13	5.40

C1: Control labneh made from full fat milk. C2: Control labneh made from low fat milk 0.1% without adding barley β-glucan. Exp. 1: Experimental labneh made from low fat milk (25%) containing 5% barley β-glucan. Exp. 2: Experimental labneh made from low fat milk (50%) containing 5% barley β-glucan. Exp. 3: Experimental labneh made from low fat milk (75%) containing 5% barley β-glucan

Yeast and Mould

The data presented in Table 1 demonstrate the well known observation that yeast and mould show physical appearance after a period at least 8 days (Al-Kadamany *et al*., 2003). However, yeast and mould counts did not show significant differences in all treatments and the slight increase in some treatments may be attributed to contamination of polyethylene vessels.

Coliform Bacteria Count

All samples of labneh treatments fresh and stored made with different treatment were coliform bacteria free or <10 cfu g^{-1}). This may due to the efficient heat treatment and high sanitation conditions during manufacture and storage. These results are in agreement with the results reported by Tamime *et al*. (1989) who stated that the coliforms were not detected all over storage period in yoghurt at the beginning and end of the storage periods.

Chemical Compositions

The data set in Table 2 show the means value of fat, moisture and protein content in labneh made from low fat content milk incorporated with barley beta glucan together with controls. A striking feature of these data in that there was a remarkable increase in the yield of labneh with increase in addition of β-glucan. This observation may be attributed to high moisture content that enhanced the formation hydrocolloids (Bullens *et al*., 1994; Volikakis *et al*., 2004). The seemingly high protein content is only due to reduction in fat content which in turn, besides β-glucan, enhanced water binding capacity of the product. As regards the level of lactose and ash, there were significant differences ($p<0.05$) between the control and all other treatments.

Table 2: Effect of reduction in fat content of labneh milk containing barley β-glucan on the mean values of total solid, protein, fat, ash and lactose of the experimental labneh products

Treatments	TS (%)	Protein (%)	Fat (%)	Ash	Lactose (mg)
C1	23.91±0.20	8.79±0.79	9.86±0.14	0.89±0.05	4.12±0.05
C2	20.64±0.33	8.99±0.01	0.40±0.10	0.99±0.02	4.11±0.04
Exp. 1	21.28±0.15	9.96±0.21	3.53±0.02	1.00±0.50	4.08±0.03
Exp. 2	22.82±1.03	9.19±0.21	5.04±0.07	1.08±0.03	4.09±0.06
Exp. 3	22.89±0.19	9.29±0.25	6.88±0.13	1.03±0.02	4.06±0.04

C1: Control labneh made from full fat milk. C2: Control labneh made from low fat milk 0.1% without adding barley β-glucan. Exp. 1: Labneh made from low fat milk 25% reduction in milk fat content of cow milk containing 5% barley β-glucan. Exp. 2: Labneh made from low fat milk 50% reduction in milk fat content of cow milk containing 5% barley β-glucan. Exp. 3: Labneh made from low fat milk 75% reduction in milk fat content of cow milk containing 5% barley β-glucan

Table 3: Effect of reduction in fat content of labneh milk and addition of the β-glucan on the mean values of pH and acidity content of the experimental labneh products during storage period of 30 days at 5°C

Storage period	pH values					Acidity (%)				
(Days)	C1	C2	Exp. 1	Exp. 2	Exp. 3	C1	C2	Exp. 1	Exp. 2	Exp. 3
Fresh	4.71	4.69	4.47	4.39	4.37	0.92	0.93	0.99	0.99	1.01
4	4.57	4.55	4.27	4.22	4.21	1.16	1.17	1.23	1.21	1.26
8	4.11	4.09	3.98	3.89	3.87	1.31	1.29	1.31	1.39	1.37
18	3.95	3.89	3.77	3.73	3.72	1.63	1.64	1.63	1.64	1.65
30	3.53	3.49	3.40	3.36	3.36	1.96	1.98	2.01	2.09	2.21

C1: Control labneh made from full milk. C2: Control labneh that made from low fat milk (0.1%) without adding beta glucan. Exp. 1: Experimental labneh made from low fat milk (25%) containing 5% barley β-glucan. Exp. 2: Experimental labneh made from low fat milk 50% containing 5% barley β-glucan. Exp. 3: Experimental labneh made from low fat milk 75% containing 5% barley β-glucan

The data in Table 3 indicate that there were no appreciable differences in pH value for all treatments devoid of β-glucan. However, substantial differences are observed for C1, C2 (controls) and the experimental Exp. 1, Exp. 2 and Exp. 3. These results are in the good agreement with the observations reported by Volikakis *et al*. (2004), who have done similar experiments in the manufacture of white brand cheese incorporated with oat β-glucan. In addition, acidity was observed to increase with increasing period of storage, a fact that is supported by the findings of Al-Kadamany *et al*. (2003) and Moussa and Abd El-Gawad (2007).

Acetaldehyde and Diacetyl Concentrations

In this study, the concentration of acetaldehyde was found to increase with time of storage, reaching a maximum at the end of 18 days and experiences a regular decrease afterwards till the end of storage period of 30 days. Similar findings were observed in the manufacture of maize porridge with malted barley (Helland *et al*., 2004). The decrease in acetaldehyde opens a new way for its conversion to ethanol via the action of the enzyme alcohol dehydrogenise (Tamime and Robinson, 1999). Moreover, there was an increase in the concentration of the acid during the storage period for all treatments i.e., from 0.17 to 0.77 μmol mL^{-1} presumably due to consumption of available nutritive maternal by the organisms. These results were in accordance with those reported by Guezel *et al*. (2000).

Sensory Evaluation

Table 4 contains the date concerned with the general appearance of labneh acceptability made from all treatments employed in this investigation. It was found that the most acceptable labneh was the one obtained with 25 and 50% reduction in milk fat content incorporated with 5% barley β-glucan.

Table 4: Means of taste panel scores for fresh and stored labneh

Treatment	Storage period (days)	Flavor	Appearance	Texture	Over all acceptability
C1	Zero	8.5[a]	8.3[a]	7.8[a]	7.8[a]
C2		6.8[a]	8.2[a]	6.8[a]	6.6[a]
Exp. 1		8.3[a]	8.1[a]	8.5[a]	7.7[a]
Exp. 2		8.4[a]	8.4[a]	8.6[a]	8.4[a]
Exp. 3		7.6[a]	8.3[a]	8.7[a]	8.3[a]
C1	4	8.6[a]	8.3[a]	8.4[a]	7.5[a]
C2		6.8[a]	8.1[a]	7.3[a]	6.3[a]
Exp. 1		8.3[a]	8.3[a]	8.1[a]	78[a]
Exp. 2		8.4[a]	8.2[a]	8.3[a]	7.7[a]
Exp. 3		8.2[a]	8.4[a]	8.4[a]	7.5[a]
C1	8	8.1[a]	8.1[a]	8.3[a]	6.7[a]
C2		6.4[a]	7.9[a]	6.7[a]	6.1[b]
Exp. 1		7.8[a]	8.1[a]	8.1[a]	7.5[a]
Exp. 2		7.9[a]	8.0[a]	8.2[a]	7.5[a]
Exp. 3		8.0[a]	8.1[a]	8.3[a]	7.4[a]
C1	18	7.8[a]	8.2	8.3[a]	6.4[b]
C2		6.1[a]	7.8[a]	6.3[b]	5.5[b]
Exp. 1		7.5[a]	8.0[a]	8.2[a]	7.2[a]
Exp. 2		7.7[a]	8.1	8.3[a]	7.1[a]
Exp. 3		7.9[a]	8.0[a]	8.4	6.9[a]
C1	30	7.2[a]	8.3[a]	8.3[a]	6.2[b]
C2		5.9[a]	7.8[a]	5.7[a]	5.4[b]
Exp. 1		7.3[a]	8.4[a]	8.3[a]	6.8[b]
Exp. 2		7.3[a]	8.1[a]	8.2[a]	6.7[a]
Exp. 3		7.4[a]	8.2[a]	8.4[a]	6.5[a1]

[1]Nine-point scale (9 = like extremely, 5 = neither like nor dislike and 1 = extreme dislike). [2]Mean are average of 2 trial (duplicates). [3]Samples as defined under Table 1 [a, b, c, d]Means in the same column within a trail with no common superscript are significantly different

The mean scores for flavor, texture and overall acceptability of fresh and stored labneh made by the procedure were significantly higher ($p<0.05$) than those obtained from labneh made with full fat milk and 0.1 fat milk. On the other hand, the least acceptable labneh was that obtained without incorporation barley β-glucan and the one obtained from milk fat 0.1. Similar observations were reported for cow labneh (Al-Kadamany *et al*., 2003). However, labneh obtained from 50% reduction fat content and incorporated with 5% β-glucan was found be relatively more acceptable than that obtained from other treatments.

Organic Acids Profile

The data set in Table 5 shows the mean value of the concentration of the organic acids: lactic, acetic, formic, pyruvic and citric acids contents as determined by the method described in the experimental section by HPLC. In general the concentration of theses acids increase with the increase in time of storage. Lactic acid, in particular had a significantly high concentration in labneh made from C1 i.e., full-fat milk. The inverse relation between fat content of milk and rate of production of lactic acid could be related to difference in microbial activity. This observation was also reported by other researchers in this field (Laloy *et al*., 1996). The rate of production of acetic, pyrovic and formic acids has generally shown an increase in concentration after 18 days storage in the samples obtained when β-glucan was employed. Citric acid has followed a different rate because gradual increase in its concentration was observed at the beginning reaching a high value at 18 days storage period and thereafter started to decrease. This observation was also reported by Rasic and Kurman (1978), Barrantes *et al*. (1996) and Volikakis *et al*. (2004) who claimed that citric acid was utilized by the starter culture. Generally, the mean levels of acetic acid found in all treatments were having a rather low values than vales reported by Kondyli *et al*. (2002), for full-fat and low-fat Feta-type cheese as determined by GC after 120 and 180 days of ripening.

Table 5: Effect of reduction in fat content of labneh containing β-glucan on the organic acids content of lanbeh

		Organic Acids (mg/100 g)				
Treatments	Storage period (days)	Lactic	Acetic	Citric	Formic	Pyruvic
C1	Zero	168.8	nd	279.8	nd	nd
C2		208.3	nd	312.7	nd	nd
Exp. 1		296.2	nd	361.8	nd	nd
Exp. 2		259.7	nd	346.3	nd	nd
Exp. 3		239.4	nd	361.2	nd	nd
C1	4	189.3	nd	308.5	nd	nd
C2		217.5	nd	329.9	nd	nd
Exp. 1		315.3	nd	398.9	nd	nd
Exp. 2		272.4	nd	350.2	nd	nd
Exp. 3		247.1	nd	348.9	nd	nd
C1	8	198.0	7.40	321.6	nd	nd
C2		221.4	5.60	332.6	nd	nd
Exp. 1		332.6	18.2	339.7	nd	nd
Exp. 2		281.5	11.9	423.9	nd	nd
Exp. 3		253.2	9.10	372.4	nd	nd
C1	18	209.1	13.6	278.9	26.5	19.2
C2		238.3	9.2	271.6	28.0	26.0
Exp. 1		277.4	21.9	289.3	39.5	38.0
Exp. 2		297.7	14.3	386.6	34.6	33.0
Exp. 3		269.6	8.5	323.0	31.6	30.0
C1	30	229.4	17.1	214.8	36.7	24.0
C2		259.5	14.3	209.1	33.1	31.0
Exp. 1		414.8	32.5	232.8	44.6	46.0
Exp. 2		360.3	21.1	240.6	41.9	41.0
Exp. 3		318.5	14.7	215.8	41.1	34.0

The results in this table are average of all readings obtained from the three preparation, nd: Not determined

From the above observations relating to all treatments investigated in this study, as regards organic acids profile it would be reasonable to assume that a fermentation process could have occurred to β-glucan thereby resulting in the consequent increase in the concentrations of these organic acids.

CONCLUSION

A low fat labneh product from cow milk with barley β-glucan has been made and fermented by probiotic bacteria. The labneh that made with barley β-glucan is higher level in organic acids. The sensory measurements showed an improve in the texture of the labneh and the products was creamy higher than the control labnehs. The colour, flavor and overall impression score were significantly inferior to those of typical control labneh Aroma. The labneh samples with barley β-glucan and was highest creaminess and mouth fell. The incorporation of barley β-glucan in labneh milk as fat replacer and functional ingredients improved and increased the growth and the survival of probiotic bacteria (*Bif. lactis* Bb-12 and *Lactobacillus acidophilus* LA-5 during storage period. Therefore, the used of 5% barley β-glucan (w/w) could be reasonable concentration to use in the production of low fat labneh or dairy products. The mixed substrate could be considered raw material for production with improved functionality and superior health effects without differences in the sensory quality.

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