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Manufacture of Functional Labneh Using Uf-Retentate and Artichoke Puree

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ABSTRACT

Artichoke, UF-retentate and Bifidobacteria were used in success to manufacture novel functional labneh treatments in this study. Artichoke (*Cynara scolymus* L.) puree was added in ratios of 0, 15, 30 and 45% of the formula. *Bifidobacterium bifidum*, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (1:1) were added to produce lactic acid and healthy compounds. Total solids, fat/dry matter, ash, pH values, Total Nitrogen (TN), Soluble Nitrogen (SN) contents and Total Volatile Fatty Acids (TVFA) were determined. All samples texture profile measurements were also carried out. *Streptococcus thermophilus* continuously increased in all treatments followed by slight decrease towards the end of the storage period especially with control. Also, *Bifidobacterium bifidium* numerous increased during storage period to reach up to log 9.00 CFU g^{-1} especially in the treatment that contained 30% artichoke puree. Results demonstrated that artichoke is a suitable food carrier that allows the survival of potentially probiotic strains. Preferences of treated samples 15 and 30% artichoke puree were as well as the control especially in outer appearance and flavour.

Key words: Functional labneh, artichoke puree, UF-retentate, *Bifidobacterium bifidum*, *Lactobacillus bulgaricus*, *Streptococcus thermophilus*

INTRODUCTION

Labneh is a traditional fermented milk product. It is a popular food in various parts of the world especially in the Middle East regions, where it plays a significant role in the family diet. It has increased in popularity during the last decade. It's perceived nutritional benefits and storage characteristics have led to increase its economic importance (Shamsia and El-Ghannam, 2012).

Artichoke (*Cynara scolymus* L.) is considered a healthy food due to its nutritional and chemical composition. Artichoke contains proteins, minerals, low amount of lipids, dietary fibers and high proportion of phenolic compounds (El-Sohaimy, 2013). Historically, this plant has been used in folk medicine since Roman times, for its health benefits, which are mainly due to the high content of polyphenols and inulin (Lattanzio *et al*., 2009; Tarakci *et al*., 2011). Artichoke is very beneficial to the liver; recent studies have found that it may even regenerate liver tissue. Studies on artichoke demonstrated its health protective potential, especially their hepatoprotective (Gebhardt, 1997; Aktay *et al*., 2000) anticarcinogenic (Wang *et al*., 2003), hypocholesterolemic activities (Lupattelli *et al*., 2004) and antimicrobial (Zhu *et al*., 2004). The two major phytonutrients found

in artichokes are cynarin and silymarin. These are of particular interest for their ability to lower cholesterol, protect and support liver function, increase bile production and prevent gallstones (Ceccarelli *et al.,* 2010). Inulin in artichoke is a plant-derived highly water-soluble carbohydrate with the benefits of soluble dietary fibers which are not digested or absorbed in the small intestine because humans lack enzymes required for hydrolysis of fructans but fermented in the colon by beneficial bacteria. Functioning as a prebiotic, inulin has been associated with enhancing the gastrointestinal system and immunity system. In addition, it has been shown that, it increases the absorption of calcium and magnesium, influences the formation of blood glucose and reduces the level of cholesterol, serum lipoproteins (Coudray *et al*., 1997; Niness, 1999). FAO/WHO (2001) defines probiotic as: "Live microorganisms which when administered in adequate amounts confer a health benefit on the host". Several genera of bacteria (and yeast) have been proposed as probiotic cultures, the most commonly used are *Lactobacillus* and *Bifidobacterium* species. Microorganisms of the genus *Bifidobacterium* are nonspore forming, nonmotile and nonfilamentous rods, which can display various shapes. They can be found singularly, as chains, as aggregates, as "V" shape or as palisade arrangements when grown under laboratory conditions. They are strictly anaerobic (Scardovi, 1986). Bifidobacteria, naturally present in the dominant colonic microbiota, represent up to 25% of the cultivable fecal bacteria in adults and 80% in infants. As probiotic agents, bifidobacteria have been studied for their efficacy in prevention and treatment of a broad spectrum of animal and/or human gastrointestinal disorders, such as colonic transit disorders, intestinal infections and colonic adenomas and cancer. The use of bifidobacteria in fermented dairy products is GRAS "Generally Recognized As Safe" status of certain strains attest to their safety. Bifidobacteria are able to prevent or alleviate infectious diarrhea through their effects on the immune system and resistance to colonization by pathogens (Picard *et al.,* 2005).

The combination of prebiotic as inulin and probiotic as *Bifidobacterium* can produce synbiotic products that have beneficial properties for human health. The research cleared that, artichoke puree has not been used before in the manufacture of dairy products.

So, this study aimed to produce new synbiotic labneh using artichoke puree, as a source of many nutrients especially inulin and Bifidobacteria.

MATERIALS AND METHODS

Materials: Fresh full fat UF-retentate was procured from Animal Production Research Institute, Agriculture Research Center, Dokki, Egypt. Artichoke was purchased from the local market. Extra virgin olive oil produced by Elsalheya, were purchased from Agriculture Research Center, Giza, Egypt.

Bacterial strains: *Lactobacillus delbrueckii* subsp. *bulgaricus* Lb-12 DRI-VAC, provided by Northern Regional Research Laboratory. Illinois, USA. *Streptococcus thermophilus* CH-1 obtained from Chr. Hansens's Lab., Denmark. *Bifidobacterium bifidum* was provided by Chr. Hansens's Lab., Denmark.

Methods

Preparation of Artichoke (*Cynara cardunculus* L.) puree: Artichoke (*Cynara scolymus* L.) fresh puree was prepared by removing outer peels. Artichoke heads were left in boiled water for 5 min to inhibit the oxidative enzymes and to prevent colouring changes. Artichoke treated heads were cut into small portions to be suitable for the milling machine (Braun mincer, Germany), then puree was filtrated to separate unmilled portions.

Preparation of functional labneh: Labneh were made using the method described by Shamsia and El-Ghannam (2012). UF-retentate were heated to 72°C for 3-5 min and then cooled to 42°C. Artichoke puree mixed with UF-retentate in ratios of 0, 15, 30 and 45%, using the electric blender (Molinex blender).

UF-retentate artichoke puree mixture were inoculated with *Bifidobacterium bifidum*, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (1:1) and packaged in plastic yoghurt cups (70 mL). Layer of olive oil were added at the surface of the cups. All cups were incubated at 42°C till coagulation. Treatments were stored at refrigerator (5±2°C) till the end of storage period. Samples of labneh were analyzed for texture profile changes. Chemical, microbiological and sensory attributes, were determined when fresh and during storage.

Chemical analysis: Fresh labneh samples were chemically analyzed for total solids, fat/dry matter and ash content according to AOAC (2007). The pH values were measured using a digital laboratory Jenway 3510 pH meter, UK. Bibby Scientific LTD. Stone, Stafford shire, ST 15 OSA. Total Nitrogen (TN) and Soluble Nitrogen (SN) contents were determined using the semi micro-Kjeldal method as mentioned by Ling (1963). Total Volatile Fatty Acids (TVFA) value was determined according to the method described by Koiskowski (1982), values were expressed as mL of 0.1 M NaOH/100 g labneh. Fiber content was determined as described in AOAC (2007) Antioxidants, DPPH, Phenolic acid were detected according to Zheng and Wang (2001). The content of inulin was determined according to AOAC (1965).

Texture profile analysis of functional labneh: Texture profile samples measurements were carried out according to Bourne (2003) with universal testing machine (Cometech, B type, Taiwan) provided with software. Back extrusion cell with 35 mm diameter compression disc was used. Two cycles were applied, at a constant crosshead velocity of 1 mm sec^{-1}, to 25% of sample depth and then returned. From the resulting force-time curve, the values for texture attributes, i.e., Firmness (N), gumminess (N), chewiness (N), adhesiveness (N.s), cohesiveness, springiness and resilience were calculated from the TPA graphic.

Microbiological analysis

Viable total bacterial counts: Viable total bacterial counts were enumerated using plate count agar medium (Oxoid). The plates were incubated aerobically at 37°C for 48 h (APHA., 1992a, b).

Lactobacilli counts: *Lactobacillus bulgaricus* counts were enumerated using De Man-Rogosa-Sharpe (MRS) agar, according to De Man *et al.* (1960). The plates were incubated at 37°C for 48 h under anaerobic condition.

Streptococci counts: *Streptococcus thermophilus* counts were enumerated aerobically at 35°C for 48 h using M17 agar according to Terzaghi and Sandine (1975).

***Bifidobacterium bifidum* counts:** *Bifidobacterium bifidum* counts were enumerated by the method described by Vinderola and Reinheimer (1999) using MRS agar supplemented with 0.5% of L-cysteine solution and 10% of lithium chloride solution. The plates incubated at 37°C for 72 h under anaerobic conditions.

Yeast and mold counts: Yeast and Mold counts were enumerated using potato dextrose agar acidified to pH 3.5 with sterile lactic acid solution (10% conc.) as described in APHA. (1994). The plates were aerobically incubated at 25°C for 4 days.

Coliform bacterial counts: Coliform bacterial counts were enumerated at 37°C for 18 h according to Mossel (1985) using violet red bile agar medium.

Sensory evaluation properties: Fresh and stored labneh samples were evaluated for their organoleptic properties. Outer appearance (10 points), body and texture (10 points) and Flavor (10 points) were evaluated, when fresh and during storage till 30 days at refrigerator (5±2°C) by members of National Research Center (NRC) according to score card described by Tarakci *et al*. (2011).

Statistical analysis: Statistical analysis was performed using ANOVA (SPSS., 2011). Significant differences between groups were detected using tukey HSD test (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

Chemical composition: Chemical composition of functional labneh using artichoke puree, UF-retentate and Bifidobacteria are presented in Table 1. The determined date cleared that the control treatment has total solids content of 29.75%, although, for artichoke puree treatments TS varied from 28.78 to 26.49%. Total solids content decreased by increasing the added ratio of the artichoke puree. This variation in TS could be due to the moisture content of the artichoke puree which affected TS content of treatments. The data also cleared that, the control F/DM content was 33.94% even F/DM were 29.73, 26.99 and 23.39% for the artichoke puree treatments. The more increase of added artichoke puree the more decrease of added UF-retentate. The UF-retentate is the main source of fat in the blends, this could be the reason for the decrease in F/DM content. Control treatment has the highest ratio of TN, when compared with the treatments of artichoke. For ash, the more added artichoke puree the more ash value determined. This could be due to the high mineral and fiber content of the added artichoke puree.

Table 1, also presented antioxidant activity 1, 1-diphenyl-2-picrylhydrazyl (DPPH) Phenolic acid, fiber and inulin content of both control and functional Labneh samples. From Table 1 it can be noticed that, antioxidant activity was 4.97 for control and reached up to 21.75% for functional labneh with 45% artichoke puree. The antioxidant activity increased by increasing the added ratio of artichoke puree in the labneh formula up to 45% compared with the control. Also, phenolic acid (mg/100 g) content increased by increasing artichoke puree in the formula, the maximum value noticed with the treatment T_3.

From our knowledge that, milk and dairy products are poor in fiber content so, the use of artichoke puree in the manufacture of functional labneh was as supplementation by an important

Table 1: Chemical composition of functional labneh using UF-retentate and artichoke puree

Treatments*	TS (%)	F/DM (%)	TN (%)	Ash (%)	Fiber (%)	Inulin (%)	DPPH (%)	Phenolic acid (mg/100 g)
C	29.75±0.44^{A}	33.94±0.45^{A}	1.84±0.17^{A}	1.13±0.92^{C}	0.00±0.00^{D}	0.0123±0.19^{D}	4.97±0.91^{D}	6.89±0.75^{D}
T_1	28.78±0.44^{B}	29.73±0.45^{B}	1.56±0.16^{B}	1.25±0.10^{B}	3.37±0.84^{BC}	0.0137±0.19^{C}	8.47±0.91^{C}	7.92±0.77^{C}
T_2	27.41±0.30^{C}	26.99±0.49^{C}	1.52±0.17^{BC}	1.32±0.83^{A}	3.68±0.84^{B}	0.0251±0.25^{B}	13.45±0.90^{B}	9.69±0.74^{B}
T_3	26.49±0.30^{D}	23.39±0.03^{D}	1.45±0.15^{D}	1.33±0.83^{A}	4.32±0.93^{A}	0.0257±0.21^{A}	21.75±0.90^{A}	15.50±0.75^{A}

*C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree, Data expressed as mean of 3 replicates±SD, ^{A,B,C}Means with the same letter among treatments in the same storage period (column) are not significantly different ($p \leq 0.05$)

Table 2: Texture profile analysis of functional labneh using UF-retentate and artichoke puree

Treatment*	Firmness	Cohesiveness	Gumminess	Chewiness	Springiness	Resilience
C	2.210	0.233	0.515	0.125	0.243	0.127
T_1	1.910	0.621	1.186	0.648	0.546	0.439
T_2	1.570	0.578	0.908	0.643	0.521	0.390
T_3	1.470	0.429	0.631	0.313	0.497	0.233

*C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree

nutrient component as fiber. Moreover, inulin content in functional labneh increased by increasing the added artichoke puree to exhibit values of 0.0123, 0.137, 0.0251 and 0.0257 for 0, 15, 30 and 45% artichoke puree treatments, respectively. Artichoke is an important source of many nutrients mainly fiber and inulin (Metwally *et al*., 2011; Kim *et al*., 2013).

Texture profile analysis: Texture profile analysis of functional labneh using artichoke puree, UF-retentate and Bifidobacteria are illustrated in Table 2. The tables showed that firmness values were being the highest in the control treatment, decreased gradually by increasing the added ratios of artichoke to the formula. The decrease was more observed in treatment T_3, which has the lowest value of firmness. These observations could be related to the ratio of TS, which being the highest in the control and has an effect on labneh firmness.

Cohesiveness: The strength of internal bonds making up the body of the product (the greater the value the greater the cohesiveness). Treatment T_1 has the greater value of cohesiveness. Treatment T_1 has the lowest content of fiber compared to other artichoke treatments. It is clear that the content of low fiber ratio affect the moister binding and the internal bonds of the treatments. In treatment T_3 the increase of fiber content has undesirable reflecting effect on the moisture binding and the internal bonds of the treatments. The control treatment has no fiber content and no protein network, so it was the lowest in the cohesiveness among all treatments.

Gumminess: Energy required to disintegrate a semi-solid food product to a state ready for swallowing. This energy has been more excessive by presence of low fiber content, acting as a water binding material. Gumminess was decreased when the UF-retentate replacement increased by artichoke.

Chewiness: The energy required to chew a solid food to the point required for swallowing it. The control treatment has no protein network, so it requires light energy to chew; moreover the content of acidity has an effect on the protein-protein interactions. Otherwise, in treatments of artichoke the content of fiber required more energy for each treatment to chew.

Springiness: Ratio of the height sample the springs back after the first compression compared to the maximum deformation. From the Table 2, it can be noticed that treatment T_1 has the greatest value among all treatments even the control. This means that, treatment T_1 has the most ability to springs back after the first compression. Also it can be noticed that different trend observed for other treatments including the control. These could be related to the pH values of the treatments. The F/DM content in control treatment could be another cause of the decreased value of the springiness.

Table 3: pH values of functional labneh using UF-retentate and artichoke puree, when fresh and during storage

	Storage period (days)					
Treatments*	Fresh	7	15	21	30	Overall means
C	4.99±00.100^{Ba}	4.92±0.0100^{Ba}	4.89±0.0200^{Ab}	4.87±0.0200^{Ab}	4.65±0.0200^{Ac}	4.86±0.125^{b}
T_1	5.10±0.0100^{Aa}	5.04±0.0200^{Aa}	4.85±0.577^{Ab}	4.74±0.0100^{Bb}	4.63±0.0200^{Ac}	5.00±0.390^{a}
T_2	5.08±0.0200^{Aa}	4.91±0.0200^{Bb}	4.82±0.0200^{Ab}	4.70±0.0100^{Bc}	4.60±0.0200^{Ad}	4.82±0.170^{bc}
T_3	4.95±0.0100^{Ba}	4.75±0.0200^{Cb}	4.72±0.0200^{Bb}	4.68±0.0200^{Cbc}	4.59±0.027^{ABc}	4.73±0.244^{c}
Overall means	5.03±0.089^{Ba}	4.90±0.108^{B}	4.98±0.408^{AB}	4.74±0.078^{C}	4.62±0.027^{D}	

*C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree, Data expressed as mean of 3 replicates±SD. ^{A,B,C}Means with the same letter among treatments in the same storage period (column) are not significantly different ($p \leq 0.05$), ^{a,b,c}Means with the same letter in the same treatment during storage periods (row) are not significantly different ($p \leq 0.05$)

Table 4: Soluble nitrogen content (%) of functional labneh using UF-retentate and artichoke puree, when fresh and during storage

	Storage period (days)					
Treatments*	Fresh	7	15	21	30	Overall means
C	0.362±0.005^{Acd}	0.393±0.003^{Bcd}	0.445±0.005^{Ac}	0.522±0.005^{Ab}	0.666±0.003^{Aa}	0.477±0.112^{a}
T_1	0.353±0.003^{Abd}	0.441±0.003^{Acd}	0.448±0.002^{Ac}	0.478±0.002^{Bb}	0.544±0.003^{Ca}	0.452±0.063^{b}
T_2	0.368±0.002^{Ad}	0.407±0.003^{Bc}	0.445±0.005^{Abc}	0.464±0.002^{Cb}	0.489±0.004^{Da}	0.434±0.044^{c}
T_3	0.333±0.003^{Abd}	0.379±0.005^{Ccd}	0.385±0.005^{Bc}	0.415±0.004^{Db}	0.559±0.004^{Ba}	0.414±0.079^{d}
Overall means	0.354±0.0141^{E}	0.405±0.248^{D}	0.430±0.027^{C}	0.469±0.0399^{B}	0.564±0.067^{A}	

*C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree, Data expressed as mean of 3 replicates±SD, ^{a,b,c}Means with the same letter among treatments in the same storage period (column) are not significantly different ($p \leq 0.05$), ^{a,b,c}Means with the same letter in the same treatment during storage periods (row) are not significantly different ($p \leq 0.05$)

Resilience: Measurement of how a sample recovers from deformation in relation to speed and forces derived. The trend of the resilience is the same trend of cohesiveness. The causes affecting cohesiveness measurements could be the same for the resilience for artichoke measurements and the control (Shamsia and El-Ghannam, 2012).

pH values: Values presented in Table 3, showed the pH of functional labneh using artichoke puree, UF-retentate and Bifidobacteria, when fresh and during storage. Fresh treatments recorded that the treatment T_1 has the highest value followed by T_2, while T_3 recorded the lowest one. The differences among treatment T_1 and the other treatments even the control was significant. These could be has a relation to the activity of added bacteria in labneh specially starter bacteria.

A decrease in pH values were observed during storage up to 30 days. At the end of storage, differences among treatments were non-significant, in spite of differences among values for each treatment when fresh and till the end of storage were significant. These could be due to the behavior of added bacteria during storage and the enzymes presented in labneh. The results agree with Ibrahim *et al.* (2013).

Soluble nitrogen content: Table 4 showed the changes in Soluble Nitrogen (SN) content in labneh treatments. Soluble nitrogen values when fresh showed that, the treatment with added artichoke in ratio of 30% has the highest value while the treatment with added artichoke 45% were has the lowest. The control treatment has a value of SN higher than that of added artichoke in ratios of 15 and 45%, respectively. Although, of these differences among the treatments, the values of differences were non-significant.

Gradual increases in SN values were observed in all treatments during storage being the highest at the end of storage period. The control treatment has the highest value followed by T_3 comparing with artichoke puree treatments T_1 and T_2. These observed changes could be due to the active proteolytic enzymes, which have an effect on the solubilization of protein. These observations agree with Ibrahim *et al.* (2013) and Agboola *et al.* (2009).

Table 5: Total volatile fatty acids values of functional labneh using UF-retentate and artichoke puree, when fresh and during storage

	Storage period (days)					
Treatments*	Fresh	7	15	21	30	Overall means
C	12.68±0.0200^{Ce}	14.97±0.0300^{Cd}	18.12±0.0200^{Dc}	18.89±0.0300^{Db}	19.79±0.0500^{Da}	16.89±0.751^{d}
T_1	15.55±0.0500^{Be}	20.72±0.0500^{Ad}	22.12±0.0200^{Bc}	24.98±0.0200^{Bb}	27.75±0.0500^{Aa}	22.22±0.266^{b}
T_2	15.14±0.0400^{Be}	20.35±0.0500^{Ad}	23.16±0.0400^{Ac}	27.17±0.0300^{Aa}	26.33±0.0300^{Bb}	22.43±0.528^{a}
T_3	16.04±0.0400^{Ae}	16.92±0.0200^{Bd}	19.89±0.0200^{Cc}	20.50±0.0500^{Cb}	24.65±0.0500^{Ca}	19.60±0.148^{c}
Overall means	14.85±0.352^{E}	18.24±0.606^{D}	20.82±0.044^{C}	22.88±0.479^{B}	24.63±0.135^{A}	

*C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree, Total volatile fatty acid: mL NaOH 0.1 M/100 g labneh, Data expressed as mean of 3 replicates±SD, ^{A,B,C}Means with the same letter among treatments in the same storage period (column) are not significantly different ($p \leq 0.05$), ^{a,b,c}Means with the same letter in the same treatment during storage periods (row) are not significantly different ($p \leq 0.05$)

Table 6: Viable total bacterial counts (Log CFU g^{-1}) of functional labneh using UF-retentate and artichoke puree, when fresh and during storage

	Storage period/days (log CFU g^{-1})					
Treatments*	Fresh	7	15	21	30	Overall means
C	8.08±0.080^{Bb}	8.11±0.110^{Ba}	8.13±0.030^{Ba}	8.07±0.050^{Cb}	8.05±0.050^{Bb}	8.07±0.074^{a}
T_1	8.11±0.010^{Ab}	8.12±0.020^{Ba}	8.15±0.050^{Ba}	8.13±0.030^{Ba}	8.10±0.530^{Ab}	8.18±0.240^{a}
T_2	8.15±0.150^{Ab}	8.19±0.085^{Aab}	8.22±0.100^{Aa}	8.18±0.080^{Aab}	8.11±.110^{Ab}	8.16±0.098^{a}
T_3	8.07±0.070^{Bb}	8.13±0.030^{Ba}	8.15±0.050^{Ba}	8.11±0.110^{Bab}	8.06±0.060^{Bb}	8.10±0.068^{a}
Overall means	8.10±0.084^{B}	8.13±0.068^{A}	8.16±0.064^{A}	8.12±0.075^{A}	8.15±0.293^{A}	

*C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree, Data expressed as mean of 3 replicates±SD, ^{A,B,C}Means with the same letter among treatments in the same storage period (column) are not significantly different ($p \leq 0.05$), ^{a,b,c}Means with the same letter in the same treatment during storage periods (row) are not significantly different ($p \leq 0.05$)

Total volatile fatty acids: Table 5 presents Total Volatile Fatty Acids (TVFA) values of functional labneh with added artichoke treatments and the control. From the recorded data it can be noticed that, fresh sample for treatment T_3 has the highest content of TVFA nevertheless, the control sample has the lowest content. Sample of treatment T_1 has a higher content than that of treatment T_2. The differences were significant among the artichoke puree treatments and the control.

After 30 days of storage an increase in TVFA values were recorded for all treatments being the highest for T_1 and being the lowest for control treatment. The differences among the treatments including the control were significant. This increase could be due to the active enzymes being present in the labneh treatments. These data agree with Ibrahim *et al.* (2013).

Viable total bacterial counts: The effect of the different concentrations of artichoke puree on population of Viable Total Bacterial Counts (VTBC) in functional labneh samples, when fresh and during storage were illustrated in Table 6. The data of fresh samples indicated that the treatment of 45% artichoke puree has the lowest viable total bacterial counts followed by the control, 15 and then 30% artichoke puree treatment, which has the higher numerous of viable total bacterial counts.

The respective VTBC increased gradually in all treatments up to 15 days of storage and slightly decreased at the end of storage. These could be due to the artichoke nutrients provide the total bacterial to survive. Globe artichoke has a low content of fat and high levels of minerals, vitamin C, fibers, polyphenols, flavones and inulin, which increased the rate of bacterial survival Pandino *et al.* (2011a, b). The total bacterial counts were exhibited overall means of 8.18, 8.16 and 8.10 log CFU g^{-1} for the treatments T_1, T_2 and T_3, respectively compared with control which has overall mean of 8.07 log CFU g^{-1}.

Table 7: Viability of *Lactobacillus bulgaricus* (Log CFU g^{-1}) of functional labneh using UF-retentate and artichoke puree, when fresh and during storage

	Storage period/days (log CFU g^{-1})					
Treatments*	Fresh	7	15	21	30	Overall means
C	8.36±0.030^{Ba}	8.38±0.025^{Ba}	8.37±0.040^{Ba}	8.35±0.050^{Bb}	8.33±0.030^{Cb}	8.35±0.034^{c}
T_1	8.43±0.030^{Ab}	8.45±0.050^{Aa}	8.46±0.040^{ABa}	8.44±0.040^{ABb}	8.42±0.040^{Bc}	8.44±0.037^{b}
T_2	8.46±0.040^{Ab}	8.49±0.050^{Aa}	8.50±0.050^{Aa}	8.49±0.040^{Aa}	8.48±0.080^{Aa}	8.48±0.047^{a}
T_3	8.33±0.030^{Bb}	8.35±0.050^{Ba}	8.36±0.040^{Ba}	8.34±0.040^{Ba}	8.32±0.040^{Cb}	8.34±0.037^{c}
Overall means	8.39±0.061^{B}	8.41±0.069^{A}	8.42±0.071^{A}	8.40±0.074^{A}	8.38±0.070^{B}	

*C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree, Data expressed as mean of 3 replicates±SD, ^{A,B,C}Means with the same letter among treatments in the same storage period (column) are not significantly different ($p \leq 0.05$), ^{a,b,c}Means with the same letter in the same treatment during storage periods (row) are not significantly different ($p \leq 0.05$)

Table 8: Viability of *Streptococcus thermophilus* (Log CFU g^{-1}) of functional labneh using UF-retentate and artichoke puree, when fresh and during storage

	Storage period/days (log CFU g^{-1})					
Treatments*	Fresh	7	15	21	30	Overall means
C	8.10±0.100^{Dd}	8.12±0.012^{Db}	8.16±0.160^{Da}	8.14±0.014^{Da}	8.09±0.90^{Dd}	8.12±0.100^{c}
T_1	8.21±0.210^{Bd}	8.25±0.250^{Bc}	8.30±0.300^{Ba}	8.29±0.090^{Ba}	8.27±0.130^{Bb}	8.25±0.180^{bc}
T_2	8.27±0.070^{Ac}	8.40±0.300^{Aa}	8.37±0.300^{Aa}	8.35±0.060^{Ab}	8.34±0.040^{Ab}	8.34±0.130^{a}
T_3	8.16±0.160^{Cb}	8.18±0.180^{Cc}	8.23±0.300^{Ca}	8.21±0.011^{Ca}	8.17±0.017^{Cb}	8.10±0.120^{c}
Overall means	8.18±0.140^{B}	8.23±0.219^{A}	8.26±0.160^{A}	8.24±0.123^{A}	8.21±0.140^{B}	

*C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree, Data expressed as mean of 3 replicates±SD, ^{A,B,C}Means with the same letter among treatments in the same storage period (column) are not significantly different ($p \leq 0.05$), ^{a,b,c}Means with the same letter in the same treatment during storage periods (row) are not significantly different ($p \leq 0.05$)

Viability of *Lactobacillus bulgaricus*: *Lactobacillus bulgaricus* survivability enumerated in functional labneh containing different concentrations of artichoke puree at the day one and at days 7, 15 and 30 of storage, Table 7. The viable count in fresh samples ranged from 8.46 to 8.33 log CFU g^{-1} for all treatments. The results showed a significant difference ($p \leq 0.05$) between the control and all treatments. Generally, *Lactobacillus bulgaricus* increased continuously in all treatments till 15 days of storage and tends to decrease towards the end of storage period. *Lactobacillus bulgaricus* ranged at the end of storage from 8.48 to 8.32 log CFU g^{-1}. The highest overall mean of the survival *L. bulgaricus* observed for T_1 and T_2. This means, that concentrations of 15 and 30% artichoke puree were the most added suitable ratios for the bacterial growth. This could be due to the nutrients of the artichoke. Lattanzio *et al.* (2009) mentioned that leaves and heads of artichoke have been found to be rich in minerals, fiber, inulin and polyphenolic compounds. Valerio *et al.* (2006) mentioned that, the ability of potentially probiotic strains of *Lactobacillus plantarum* and *Lactobacillus paracasei* to survive on artichokes were for at least 90 days.

Viable count of *Streptococcus thermophilus*: The viable count of fresh and stored *S. thermophilus* (Log CFU g^{-1}) samples of functional labneh using artichoke puree and UF-retentate are presented in Table 8. The number of *S. thermophilus* ranged from 8.10 to 8.27 log CFU g^{-1}. The results showed a significant differences ($p \leq 0.05$) among labneh treatments containing different concentrations of artichoke puree.

It can be observed that, *S. thermophilus* continuously increased till the day 15 of storage in all treatments, followed by slight decrease till the day 30 of storage. The lowest numbers of *S. thermophilus* were observed for the control. At the end of storage, the numbers ranged from 8.09 to 8.34 log CFU g^{-1} for all treatments. The high survival rate found in treatments T_1 and T_2, which have the overall means of 8.25 and 8.34 log CFU g^{-1}, respectively. These results were confirmed by Ceccarelli *et al.* (2010) and Pandino *et al.* (2011a, b).

Table 9: Viability of *Bifidobacterium bifidum* (Log CFU g^{-1}) of functional labneh using UF-retentate and artichoke puree, when fresh and during storage

	Storage period/days (log CFU g^{-1})					
Treatments*	Fresh	7	15	21	30	Overall means
C	8.32±0.120^{Cb}	8.33±0.330^{Cb}	8.35±0.150^{Ca}	8.34±0.040^{Ca}	8.30±0.100^{Cc}	8.32±0.151^{c}
T_1	8.35±0.050^{Bc}	8.99±0.010^{Ba}	9.05±0.100^{Ba}	9.00±0.100^{Ba}	8.95±0.050^{BCb}	8.86±0.270^{b}
T_2	8.46±0.060^{Ac}	9.11±0.110^{Ab}	9.20±0.123^{Aa}	9.12±0.100^{Ab}	9.10±0.100^{Ab}	8.99±0.290^{a}
T_3	8.35±0.050^{Bc}	8.95±0.050^{BCb}	9.01±0.100^{BCa}	9.00±0.100^{Ba}	8.98±0.020^{Ba}	8.85±0.270^{b}
Overall means	8.37±0.085^{B}	8.84±.350^{A}	8.90±0.350^{A}	8.86±0.32^{A}	8.83±0.330^{A}	

*C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree, Data expressed as mean of 3 replicates±SD, ^{A,B,C}Means with the same letter among treatments in the same storage period (column) are not significantly different ($p \leq 0.05$), ^{a,b,c}Means with the same letter in the same treatment during storage periods (row) are not significantly different ($p \leq 0.05$)

Viability of *Bifidobacterium bifidum*: Viability of *Bifidobacterium bifidum* in functional labneh samples, when fresh and during storage up to 30 days are shown in Table 9. The results demonstrated that, treatment T_2 was contain the greatest numerous of *B. bifidum* comparing with the other treatments including the control. Nevertheless, the differences between the control and the other samples were non-significant.

On the other hand, differences tend to be significant among treatments during storage. The detected numerous of *B. bifidum* log CFU g^{-1} were the highest at the day 15 of storage in all treatments especially, T_1 and T_2 decreased by increasing the storage period up to the day 30. The overall mean expressed by log CFU g^{-1} were 8.86 and 8.99 for T_2 and T_3, respectively compared with 8.32 log CFU g^{-1} for the control. Hellwege *et al*. (2000) observed that globe artichoke synthesizes inulin molecules with a chain length up to 200 MW. Inulin is fermented in the colon by beneficial bacteria e.g., bifidobacteria, so inulin functions as a prebiotic, Lattanzio *et al*. (2009), Frutos *et al*. (2008) and Kelly (2008). Also, EL-Sayed *et al*. (2014) studied the effect of different prebiotics (inulin, lactulose and Fructo-oligosaccharides) on the survival of probiotic strains (*Lactobacillus plantarum*, *Lactobacillus casei* and *Bifidobacterium bifidum*) and found that, the survival of all tested strains increased with the different prebiotics even in the presence of FOS.

Viability of coliform, mold and yeast: No coliform, mold and yeast counts were detected in all treatments when fresh and during storage up to the day 30. These results could be due to the pasteurization of the formulas during the manufacture of the labneh. Zhu *et al*. (2004) and Mossi and Echeverrigaray (1999) reported that, artichoke leaf extract have broad inhibitory activities against microorganisms, this could be promising the use in food industry.

Sensory evaluation of functional labneh: Table 10 presents the sensory evaluation attributes of labneh treatments from the day one and at the days 7, 15 and 30 of storage. From the data, it can be seen that, the preference of treated samples T_1 and T_2 were as well as the control especially, in outer appearance and aroma and Flavour. Although, the treatments T_1 and T_2 have a light colour degree of artichoke increased by increasing the added ratio of artichoke puree (Agboola *et al*., 2009). They have the same preference for the panelists. The sample of T_3 contains the highest ratio of the artichoke puree and has a less sensory evaluation preference comparing with the other treatments. For the outer appearance the colour tend to be light gray, body and texture were somewhat rough because of the artichoke fibers. Addition of artichoke in a high ratio were has an effect on flavor and aroma. For that, T_3 has a less preference for the panelists.

Table 10: Sensory evaluation of functional labneh using UF-retentate and artichoke puree, when fresh and during storage

	Storage period (days)					
Treatments*	Fresh	7	15	21	30	Overall means
Outer appearance (10)						
C	9.5±0.120^{Aa}	9.5±0.120^{Aa}	9.0±0.060^{Ab}	8.0±0.050^{Bc}	8.0±0.050^{Ac}	8.8±0.80^{b}
T_1	9.5±0.120^{Aa}	9.5±0.120^{Aa}	9.0±0.060^{Ab}	9.0±0.060^{Ab}	8.0±0.050^{Ac}	9.0±0.80^{a}
T_2	9.5±0.120^{Aa}	9.5±0.120^{Aa}	9.0±0.060^{Ab}	9.0±0.060^{Ab}	8.0±0.050^{Ac}	9.0±0.80^{a}
T_3	9.0±0.060^{Ba}	9.0±0.060^{Ba}	7.5±0.040^{Bb}	7.5±0.040^{Cb}	6.0±0.020^{Bc}	7.8±0.042^{c}
Overall means	9.3±0.0105^{A}	9.3±0.0105^{A}	8.6±0.055^{B}	8.3±0.052^{B}	7.5±0.042^{C}	
Body and texture (10)						
C	9.5±0.120^{Aa}	9.5±0.120^{Aa}	8.5±0.050^{Ab}	8.0±0.050^{Ac}	7.0±0.040^{Ad}	8.5±0.052^{a}
T_1	9.5±0.120^{Aa}	9.5±0.120^{Aa}	8.5±0.050^{Ab}	7.5±0.040^{Bc}	6.5±0.030^{Bd}	8.3±0.052^{a}
T_2	9.0±0.060^{Ba}	9.0±0.060^{Ba}	8.0±0.050^{Bb}	7.0±0.040^{Cc}	6.0±0.020^{Cd}	7.8±0.046^{b}
T_3	8.0±0.050^{Ca}	8.0±0.050^{Ca}	7.0±0.040^{Cb}	6.0±0.040^{D}c	5.0±0.010^{Dd}	6.8±0.038^{c}
Overall means	9.1±0.087^{A}	9.1±0.087^{A}	8.0±0.052^{B}	7.1±0.052^{C}	6.1±0.020^{D}	
Aroma and flavour (10)						
C	9.5±0.120^{Aa}	9.5±0.120^{Aa}	7.5±0.040^{Bb}	6.0±0.030^{Dc}	4.0±0.010^{Dd}	7.3±0.064^{c}
T_1	9.5±0.120^{Aa}	9.5±0.120^{Aa}	7.5±0.040^{Bb}	6.5±0.030^{Cc}	5.0±0.020^{Cd}	7.6±0.062^{b}
T_2	9.5±0.120^{Aa}	9.5±0.120^{Aa}	9.0±0.060^{Ab}	8.0±0.050^{Ac}	7.0±0.040^{Ad}	8.6±0.078^{a}
T_3	8.0±0.050^{Ba}	8.0±0.050^{Ba}	7.5±0.040^{Bb}	7.0±0.040^{Bc}	6.0±0.030^{Bd}	7.3±0.042^{c}
Overall means	9.1±0.102^{A}	9.1±0.102^{A}	7.8±0.050^{B}	6.8±0.037^{C}	5.5±0.025^{D}	

C: Control, T_1: 15% artichoke puree, T_2: 30% artichoke puree, T_3: 45% artichoke puree, Data expressed as mean of 3 replicates±SD. ^{A,B,C}Means with the same letter among treatments in the same storage period (column) are not significantly different ($p \leq 0.05$), ^{a,b,c}Means with the same letter in the same treatment during storage periods (row) are not significantly different ($p \leq 0.05$)

After 7 days of storage no differences has been observed, all samples have the same properties as well as fresh samples. By extending the storage period, T_2 was the most preferred treatment for the panelists. Acid flavor were increased in all samples in different degrees especially, the control and T_1. Bitterness or astringent taste was displayed in the control and sample of T_1 (Agboola *et al*., 2009). For outer appearance the colour in the samples of artichoke puree at surface layer still natural but at inner layers, it tends to be lighter. This could be due to the reduction occurred by the products of microorganisms' metabolism. No deterioration was observed in body and texture for all samples, the all were acceptable. At the end of storage T_2 was the most acceptable treatment for all sensory properties, when compared by the other treatments.

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