

SUPPLEMENTATION OF BIO-YOGHURT WITH JERUSALEM ARTICHOKE (*Helianthus tuberosus L.*) as a NATURAL SOURCES.

A.S. h. T. Bakr*; **Moussa, M. A. M.**** and **EL-Shahawy, A. M****

**Fac. Agric, Tanta Univ, Tanta, Egypt*

***Animal Pro. Res. Instute, Agric. Res. Center, Ministry of Agric, Egypt.*

***Amina Mahammad Amyntalshhawya@gmail.com*

ABSTRACT

Used Helianthus tuberosus (Jerusalem artichoke) as supplement to product function yoghurt to enhance native value health benefits and to improve rheological, physico-chemical and sensory properties of final product. Yoghurt was made from fresh cow's milk fortified with the conventional yoghurt starter culture containing Bifidobacterium bifidum, Streptococcus thermophilus and Lactobacillus acidophilus. Jerusalem artichoke extract (JAE) was added at levels 3, 5 and 7%. then storage for 15 days, at 5±1°C.

Results showed that moisture content was increase by increasing addition rate of JAE unit 7% (T₃) No significant difference between the control sample and the treated sample of protein, fat and ash. There were significant increase of fibers content in all treatment, compared with control. Yoghurt with 7% (T₃) had the highest content of amino acids compare with other treatments and control the data also showed that (T₂) supplementation yoghurt with (JAE) (5%) had the highest content of vitB₃ T₃ compared with other treatments. No-significant decrease in PH values at 3% JAE compared to the control sample at zero time Meanwhile, this decrease became significant with treatments 3, 5 and 7% JAE at zero, 5, 10 and 15 days storage.

The rate of syneresis increase by the rate of JAE till 7% comparing with control. Yoghurt supplemented by 5% JAE demonstrated a high rheological and physico-chemical properties than other treatment and control The total viable bacterial count TVBC between the control and the treated sample with 3% JAE had no significance difference compared to sample contained 7% JAE. lactic acid bacteria showed higher and progressive increase as seen in the samples contained JAE at levels of 3, 5

and 7% resulted in highly significance between treated samples and the control Molds and yeasts enumeration of Bio-yoghurt as affected by supplementing with JAE are registered in the same table. No numbers of these populations recorded in fresh samples as affected by higher heat of milk and the used ingredients and phenolic compounds contained in both Jerusalem artichoke. Psychrophilic bacteria showed that it did not detect in Bio- yoghurt wither supplemented with JAE at different levels of supplementation.

***Conclusively,** from these results, it could be concluded that supplementation dairy products with Jerusalem artichoke as treatment for diabetes. Because if it was approved that it reduces the level of glucose in blood, because they contain many vitamins and nutrients necessary and beneficial to human health.*

Key words: Supplementation, bio-yoghurt, jerusalem artichoke, (*helianthus tuberosus l.*, natural sources

INTRODUCTION

In Egypt yoghurt is one of the most popular fermented milk products and throughout the world for its therapeutic benefits and nutritional impact. The individuality of yoghurt is credited to the interdependent fermentation involved in its making. However, flavor and texture of the products are the most distinct factors that affect the superiority and acceptance of consumer to yoghurt. So, it is well known that the marketability of any food product is dependent upon four factors, namely, body, texture, flavor and shelf-life. Body and texture point to the physical nature of product. Compactness, consistency, resilience, viscosity... *etc* are terms that denote "body" characteristics. Texture describes the fine structure of a substance or its feel. Grainy, sandy, smooth and slimy are a few of the terms used in describing textural characteristics. As early as 1975, Nielson demonstrated that the factors that affect body, texture and flavor of yoghurt are: composition of the yoghurt mix, homogenization of the mix, heat treatment of the mix prior to inoculation, starter culture and incubation condition, handling of the ripened yoghurt and stabilizers used.

The efficiency of added probiotic bacteria depends on dose level, their viability must be maintained throughout storage, and they must survive in the gut environment (Kailasapathy and Chin, 2000; Aryana and McGrew, 2007).

In order to improve these features of probiotic bacteria, fermented food should be supplemented with prebiotics. There are non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity bacteria in the colon (probiotics). Fructo-oligosaccharides (FOS) and inulin are among the most famous prebiotic compounds (Buriti *et al.*, 2007; Cardarelli *et al.*, 2007).

There is species important in the food industry will be mentioned. *S. thermophilus* is used in the manufacture of yoghurt. *Lactococci*, primarily *L. lactis*, are associated with the dairy industry and the latter is actually used in dairy technology. Species of *Lactobacillus*, such as *L. acidophilus*, *L. delbrueckii*, *L. planetarium*, and *L. bulgaricus*, etc. are known in food technology. Homo fermentative lactic acid bacteria use the glycolysis, also known as the Embden-Meyerhof pathway, for hexose fermentation (Axelsson and Bjomsson, 1992).

Jerusalem artichoke (*Helianthus tuberosus L.*) is a native plant of the North American plains cultivated for different purposes in many countries. Jerusalem artichoke is a natural raw material for the derivation of a number of functional food ingredients such as inulin, oligo fructose and fructose (Kays and Nottingham, 2007) having both nutritional and functional attributes, particularly beneficial to individuals with Type 2 diabetes and obesity (Niness, 1999).

The tuber contains high amount of dietary fiber namely inulin and fructo-oligosaccharides. Inulin is a polysaccharide. Chemically, it is a linear biopolymer of D-fructose units connected by β (2,1) glycoside linkages, and terminated with one D-glucose molecule linked to the fructose chain by an α (2,1) bond. The degree of polymerization of inulin generally ranges from 2 to 60unit. Inulin has been increasingly used as functional ingredients in processed foods due to its unique characteristics (Nair *et al.*, 2010).

In addition, inulin and (FOS) improve bioavailability of minerals such as calcium, magnesium and iron, increase activity of beneficial live active cultures and inhibition of harmful bacteria in the digestive tract. Inulin facilitates the digestion of high protein diets, retards fat absorption, and provides roughage preventing constipation, remains in digestive tract providing satiety without carrying of extra calories, lowers blood cholesterol and triglycerides (Letexier *et al.* 2003), helps with blood glucose control for

diabetics (Tanjor *et al.*, 2012) and decreases incidence of colon cancer (Aryana and McGrew, 2007).

Jerusalem artichoke had long been recognized for their health benefits and nutritional value, as they are rich in fiber, protein and natural sugars

Therefore, this study was carried out to use the tuber in supplementing dairy probiotic product (yoghurt) and study their effect on chemical, physicochemical, rheological, sensory characteristics and microbial aspects. Also the tubers are analyzed for their content of fibers, protein, ash, fat, water-soluble vitamins and amino acid.

MATERIALS AND METHODS

Raw Materials: Jerusalem artichoke tubers (*Helianthus tuberosus L.*) were obtained from Horticultural Research Station, Agric. Res. Center, Dokki, Gezia, Egypt during season (2019).

Milk: Raw cow's milk was obtained from the herd of Sakha Animal Research Station, Animal Production Research, Ministry of Agriculture Egypt.

Starter culture (ABT): Starter culture (ABT) containing a mix of *Streptococcus salivarius* ssp. *Thermophilus* (ST), *Lactobacillus acidophilus* (LB) and *Bifidobacterium* sp. *Bifidum* (BB) strains which used for yoghurt production were purchased from Micro Unit (CAIRO MIRCEN), Fac. of Agric., Am Shams Univ., Cairo, Egypt.

Methods: Preparation of Jerusalem artichoke extract. Tubers were washed with tap water and any deteriorated parts were removed, then the tubers were sliced and divided to reasonable thickness by conventional food slicing machine. The sliced tubers were immersed immediately in boiling water for 2 mm following by immediate dipping in cold citric acid solution (0.5%) to inhibit polyphenol oxidase activity, then Jerusalem artichoke tuber were dried

Five gram of Jerusalem artichoke powder were suspended with distilled water to give a final volume 100 ml, then agitated at $76^{\circ}\text{C} \pm 1.0^{\circ}\text{C}$ for 20 mm using shaker. The residue was separated by refutation according to (E1-Kboly and Mahrous, 2015) with some modification that slices of tuber were dried in air oven at $55\text{-}65^{\circ}\text{C}$ until samples reached constant weight. The recovered

powder was preserve in tight polyethylene bags and stored under freezing until use according to El-Kholy and Mahrous, (2015).

Manufacturing of fortified Bio – yoghurt:

Jerusalem artichoke tuber extract was added to cow's milk at ratio 0,3, 5 and 7%(v/v) before the inoculation step to be as a source of inulin (prebiotic) besides adding the equal amount of skimmed powder milk to replace the dilution resulted from the addition of the prebiotic. Fortified cow's milk was heated to 90°C for 5 min, then cooled to 45°C where inoculated with 4% *S. thermophiles*, *L.acidophilus* and *Bifidobacteria* spp. The inoculated mixtures were mixed thoroughly, dispensed in 100 ml polystyrene cups and incubated at 42°C until a uniform coagulation was formed as reported (Barrantes *et al.*, 1994). Cups were kept at 5±1°C in refrigerator and analyzed after 0, 5, 10 and 15 days.

Chemical Analysis:

Moisture content: Crude fat, crude protein, Fiber, Ash and total solids were estimated according to the methods described in A.O.A.C.(2005).

Total carbohydrates

The standard method of the (A.O.A.C., 2000) was used. This was determined by the differences between the whole sample and the sum of the liquid, ash, protein, and the fiber composition of the sample.

$$\% \text{ Carbohydrate} = 100 - [\% \text{ Protein} + \% \text{ Fat} + \% \text{ Ash} + \% \text{ Crude Fiber}].$$

Determination of lactose content:

The lactose content was determined by subtracting the fat, protein and total ash percentages from the percentage of the total solid as described by O' Mahoney (1988).

Amino acid composition: Amino acid composition was determined by acid hydrolysis according to Block *et al.* (1958).

Rheological properties

Determination of Syneresis (%) in yoghurt: About, 100 ml of yogurt samples was placed in a graduated cylinder and stored at 4°C for hours: The volume of whey was measured. The syneresis index (%) was measured as milliliters of whey per 100gm of initial sample by using the method given by Staffolo *et al.* (2004).

Curd tension in yoghurt: Curd tension was estimated in yoghurt according to Abd El-Salam *et al.* (1991).

Determination of Viscosity: Yoghurt samples were gently stirred 5 times in clockwise direction with plastic spoon prior to viscosity measurements. Apparent viscosity was measured at 7°C using a Brookfield digital viscometer (Model DV-E, Spindle-63. rpm, 50 in yoghurt, while ice cream was spindle-64.rpm,80, Canada). The sample was subjected to shear rates. Viscosity was expressed as (CP) according to El Shenawy *et al.*(2012).

Microbiological analysis

Total lactic acid bacteria: Lactic acid bacteria count was determined according to the methods described by the American Public Health Association (1992).

Total bacterial count: Total bacterial count of samples was determined by transferring a proportion dilution into a sterile plates and pouring with plat count agar medium. The plates were incubated at 37°C for 48hrs. The colonies were counted and results were expressed as total bacterial count per gram of samples according to Difco (1984).

Mold and yeast: One ml from the first dilution in triplicate was transferred into sterile petri plates. The plates poured with potato dextrose agar medium and incubated at 24°C. The plates were successively for yeast and mold after 3 days of incubated up to 5 days according to Difco (1984).

Psychrophilic bacteria: Psychrophilic bacteria were detected by following the method of Difco (1984) using nutrient agar medium. The plates were incubated at 7°C for 5 days.

Sensory evaluation

Sensory evaluation of Bio-yoghurt:

Sensory evaluation of yogurt samples was performed at day 0 and after 15 days of storage at 5±1°C. group of panelists consisting of 10 members from department of Animal Production Research Station, Sakha, Kafr EL-Sheikh and some consumers the yoghurt samples presented in coded cups inside the individual booths at room temperature. Sensory score with degrees of intensity of yoghurt attributes such as appearance, color, texture, flavor,

and overall acceptance was used. Scoring was performed according to Kailasapathy (2006).

Statistical analysis

Data were assessed using SPSS (1997) for Microsoft Windows. Statistical results were analyzed by Duncan (1955) Multiple-Range-Test at the P<0.05 level of significance.

RESULTS AND DISCUSSION

Table (1) demonstrates the proximate chemical composition of B-yoghurt supplemented with different levels of Jerusalem artichoke extract at zero time. Obtained data showed little increase in moisture content with increasing the added ratio of Jerusalem artichoke extract up to the ratio 3,5, 7% giving the values (84.95,85.55,86.67 and 86.77%) for C, J1, J2 and J3; respectively.

There was a decrease was shown in protein, ash, and fat contents by increasing the ratios (3, 5 and 7% extract). The values ranged from 3.38 to 3.67%, 1.25 to 1.08% and from 1.27 to 0.99% for protein, ash and fat content respectively compared to the control. On the other hand, fibers showed progressive increase with significance between differences of the samples as Jerusalem artichoke extract ratios increase recording average values ranged from 0.03 to 0.09%. Total solids decreased progressively by increasing the added ratios of JA extract with average values ranging from 13.09 to 13.30%.

Table (1). Proximate chemical composition of Fresh JA Bio-yoghurt supplemented with different levels of Jerusalem artichoke extract.

Samples	Moisture	Protein	Ash	Fat	Fiber	Total Carbohydrate	T.S
C	84.95 ^{ab}	3.38 ^{ab}	1.25 ^a	1.27 ^a	0.00 ^b	8.100 ^a	13.09 ^{ab}
J ₁	85.55 ^{ab}	3.67 ^a	1.19 ^a	1.23 ^a	0.03 ^a	7.797 ^b	13.55 ^a
J ₂	86.67 ^a	3.30 ^b	1.10 ^{ab}	1.08 ^{ab}	0.04 ^a	8.185 ^{ab}	13.34 ^a
J ₃	86.77 ^a	3.40 ^a	1.08 ^b	0.99 ^b	0.09 ^a	8.577 ^a	13.30 ^a

a,b ..Means in the same column are bearing different superscripts differ significantly (P<0.05).

.JAE =Jerusalem artichoke Extract, C= Control= 100% cow milk, J1=3 % JAE J2=5 % JAE J3=7 %.

Amino acid composition content of fresh Bio- yoghurt supplemented at different levels with Jerusalem artichoke extract at zero time are presented by

Table (2). Obtained data cleared that there was progressive increase in total amino acids with significance among samples as the added ratio of JAE increased up to the ratio 7% achieving the values (0.83, 1.24, 1.74 g\100g) for the samples J₁, J₂ and J₃, respectively as compared to the control (1.22g\100g).

For the control, J₁, J₂, and J₃ samples, respectively with significant increase in differences among the control and the treatments J₁ and J₂, but this significance was decreasing with the treatment J₃ .that show progressive increase up to the ratio 7% (J₃) and significance between difference respectively. This increase in amino acids content often because of its higher content in Jerusalem artichoke tubers. The same table also shows that, threonine, leucine, tyrosine and arginine showed considerable decrease with the ratio 3and 5% then increased by increasing the added ratio of JA extract giving the values ranged from, 0.03 to 0.33 g\100g as compared to the control (0.13g\100gm) for threonine. The same trend was observed for isoleucine and leucine that ranged from 0.13 to 0.17 and 0.13 to 0.27 g\100g; respectively When compared to the control (0.22g\100g) respectively. Regularly, the NEAA; Glutamic acid and alanine behaved the same behavior and the higher content observed of the first component was with J₂ (0.93g\100gm) followed by the control sample (0.31g\100g) .

In general, considerable increase was shown in both TEAA, TNEAA and TAA, the treatment J₂ showed the highest value (3.62) of TAA followed by J₃ (3.45), J₁ (2.90) and the control (2.36g\l 00g), respectively.

Vitamin B complex (water-soluble vitamins) of Fresh Bio-yoghurt supplemented with different levels of Jerusalem artichoke Extract (ug/g) are shown in Table (3). Exhibited data showed that the control sample contained the highest content of Vit B₃(4.03ug\g) followed by the sample J₂ with 5%(3.69 and the sample with 7% extract J₃(2.02ug\g) and J₁ (1.36ug\g) respectively.

In general, it could be observed that Vit.B₃, B₁and Vit.B₂ decreased because of the consumption of these vitamins by the other organisms may be, (*L. acidophilus* On the other hand, *B. bifidum* produce B vitamins especially, pyridoxine during the manufacture of yoghurt (El-Sayed *et al.*, 2013). This was in agreement with those of Champagne *et al.*,(2010) who reported an increase in pyridoxine concentration because of fermentation with *S. thermophiles* and *Bifidobacteria spp.* It also could observed that both Vit.B₉ and Vit.B₁₂ did not detected in the product weather the control or the treatments. Moreover, Vit. C. increased steadily by increasing the added of Jerusalem extract showing the values ranging from 2.53 to3.67ug/g compared to the control.

Table (2): Amino acid composition of Fresh Bio- yoghurt supplemented with different levels of Jerusalem artichoke extract (g/100g).

Amino acid	Control Sample	Treatments		
		J ₁	J ₂	J ₃
Essential amino acids (EAA)				
Threonine	0.13 ^b	0.03 ^d	0.15 ^c	0.33 ^a
Valine	0.08 ^c	0.22 ^a	0.04 ^d	0.11 ^b
Methionine	0.07 ^c	0.11 ^b	0.05 ^d	0.19 ^a
Isoleucine	0.13 ^b	0.11 ^c	0.04 ^d	0.17 ^a
Leucine	0.22 ^b	0.13 ^c	0.06 ^d	0.27 ^a
Phenyl alanine	0.17 ^a	0.02 ^c	0.13 ^b	0.16 ^a
Tyrosine	0.15 ^b	0.03 ^c	0.13 ^b	0.31 ^a
Lysine	0.14 ^b	0.08 ^c	0.23 ^a	0.04 ^d
Histidine	0.05 ^c	0.06 ^c	0.35 ^a	0.11 ^b
Arginine	0.08 ^b	0.07 ^b	0.19 ^a	0.16 ^{ab}
Total EAA	1.22 ^c	0.83 ^d	1.24 ^b	1.74 ^a
Non -Essential amino acids				
Aspartic acid	0.32 ^{ab}	0.11 ^c	0.35 ^a	0.11 ^c
Glutamic acid	0.53 ^b	0.22 ^d	0.93 ^a	0.31 ^c
Serine	0.05 ^c	0.06 ^c	0.19 ^a	0.15 ^b
Proline	0.04 ^b	0.05 ^b	0.02 ^c	0.08 ^a
Alanine	0.07 ^c	0.11 ^b	0.08 ^c	0.18 ^a
Glycine	0.05 ^b	0.02 ^c	0.18 ^a	0.06 ^b
Cystine	0.03 ^b	0.04 ^a	0.01 ^c	0.05 ^a
Tyrosine	1.08 ^b	1.46 ^a	0.47 ^d	0.77 ^c
Total NEAA	2.17 ^{ab}	2.07 ^b	2.22 ^a	1.71 ^c

a,b ..Means in the same column are bearing different superscripts differ significantly (P<0.05). C,J1,J2andJ3 as indicted (3,5and 7%).

Table (4) illustrates the change in pH values of Bio-Yoghurt supplemented with different levels of Jerusalem artichoke extract at zero time and stored for 15 days at 5±1C. Obtained data showed that no-significant decrease in pH values at the level of the treatment supplemented with 3% JAE as compared to the control sample at zero time. Meanwhile, this decrease became significant with treatments 3, 5 and 7% JA extract at zero, after 5,10 and 15 days with the exception of the treatmentJ3 at the level of the day 10th of storage which showed non-significant increase with this parameter for the ratio 5% JAE when compared to the control.

This decrease in pH values with increasing the added JAE could be attributed to increasing the inulin content of treatments that enhance the

Table (3): Vitamin B complex water soluble vitamins (B complex and Vit c.) of Fresh JA and Bio-yoghurt supplemented with different levels of Jerusalem artichoke extract .

Vitamin(ug/g).	control	J1	J2	J3
B3	4.03 ^a	1.36 ^d	3.69 ^b	2.02 ^c
B1	1.99 ^a	0.92 ^b	0.83 ^c	0.84 ^c
B6	1.13 ^c	0.92 ^d	1.20 ^b	1.69 ^a
B9	ND	ND	ND	ND
B2	0.50 ^a	0.16 ^c	0.30 ^b	0.09 ^d
B12	ND	ND	ND	ND
The Vit.C	2.53 ^d	2.95 ^c	3.32 ^b	3.67 ^a

a,b ..Means in the same column are bearing different superscripts differ significantly (P<0.05).
J1, J2 and J3 as indicated in Table (1). ND: not detected.

Table (4): Change in pH values of Bio-yoghurt supplemented with different levels of Jerusalem artichoke extracts.

Storage period (day)	pH			
	Control	J1	J2	J3
Zero	4.60 ^{ab} ±0.04	4.50 ^{ab} ±0.05	4.45 ^c ±0.04	4.40 ^c ±0.02
5	4.51 ^b ±0.03	4.20 ^d ±0.0	4.38 ^c ±0.03	4.67 ^a ±0.07
10	4.45 ^{ab} ±0.04	4.16 ^d ±0.04	4.29 ^c ±0.01	4.52 ^{ab} ±0.04
15	4.56 ^a ±0.05	4.33 ^b ±0.06	4.37 ^b ±0.03	4.34 ^b ±0.06

a,b ..Means in the same column are bearing different superscripts differ significantly (P<0.05).
J1,J2 and J3as indicated in Table 1.

culture microorganisms' growth and in turn increasing fermentation of lactose into lactic acid. This result agreed with Zuleta *et al.* (2004) who mentioned that growth all strains of LAB was promoted by inulin on JA.

Syneresis in bio-yoghurt fortified with 3,5 and 7% JA water extract is presented by Table(5). Considerable increase was observed in curd syneresis up to the treatment J₃at zero time with significant increase compared to the control. These results could be attributed to the holding capacity of water caused by the oligosaccharides contained in Jerusalem compared to the control by the first day of storage; this increase was progressive at the level of the fresh, the day 5,10and15 the day treatments J₂ and J₃ recorded the highest value, These samples scored values ranged from (36 to 46and 41 ml\100ml) for JA samples at zero time compared to the control sample (29.53 ml\100ml).

This increase in syneresis has shown also during cold storage between treatments up to 15 days of cold storage in comparing with the control. with the ratio 7% after 10 days and 5% JA after 15 days has shown equality compared to the previous samples. Progressive significant increase also observed among all samples and the control and the sample J₁ at the level of the days 10 and 15 of storage, which was non-significant between the samples J₂ and J₃ (54.99 to 54.99 ml\100ml) but significant with the control, by increasing the storage periods up to the end period. These results had agreed with those obtained by Guven *et al.*, (2005) and Kamaly *et al.* (2011).

Finally, it can concluded that, as a result of increasing the added ratio of JA extract that led to higher water holding capacity owing to oligosaccharides contained in inulin from Jerusalem artichoke extract that represents, the prebiotic for the used probiotic culture to secret lactic acid, causing an increase in whey syneresis that decreased curd tension, moreover, decreasing viscosity of the produced bio-yoghurt as illustrated in obtained data in Table (5).

Curd tension of JA samples illustrated by the same table, showed significant decrease with increasing the added ratio of JA extract, but the treatment contained 5% extract revealed the highest curd tension of all treatments at the level of fresh samples and the lowest value after 5 days of cold storage. The average values of this estimate was from (30.58 to 25.55%) for treatments J₁ and J₃ compared to the control with significant increase with the sample J₂ (32.57%), for fresh samples and from (31 .56 to 29.55%) with higher decrease for the sample J₂(23.55%) after seven days of cold storage. This incidence decrease in curd tension of the treatments may be attributed to the higher water holding capacity in the resultant treated samples owing to the action of the contained inulin according to Guven *et al.*, (2005) and Kamaly *et al.* (2011).

On the other hand increasing cold storage period revealed significant increase in curd tension at the level of the control and the treatment J₁ and J₂ samples after 5 and 10 days at 5±1°C, Which may be attributed to the higher T.S and refrigeration according to El-Shibiny *et al.*(1977). This increase ranged from 30.57 to 35.55% for the control and from 27.54 to 35.56% for the sample J₁ compared to the fresh control (30.58g\100gm) by increasing storage period up to 10 days. Meanwhile, J₂ showed an irregular trend after 5 days of cold storage achieving a lower value. Another decrease was observed among the treatments 5% and 7% as compared to the control

Table (5): Rheological properties of Bio-yoghurt supplemented with different levels of Jerusalem artichoke extract during cold storage.

Storage period (days)	Syneresis (ml/100ml)			
	Control	J ₁	J ₂	J ₃
zero	29.53 ^d ±0.02	38.00 ^c ±0.02	46.00 ^a ±0.02	41.00 ^b ±0.07
5	25.54 ^d ±0.03	49.00 ^b ±0.05	46.09 ^c ±0.06	50.00 ^a ±0.04
10	25.63 ^c ±0.04	42.08 ^b ±0.09	54.99 ^a ±0.08	54.99 ^a ±0.03
15	24.53 ^c ±0.03	42.00 ^b ±0.07	54.99 ^a ±0.05	54.99 ^a ±0.02
Curd tension (g/100gm)				
zero	30.58 ^b ±0.07	27.55 ^c ±0.02	32.56 ^a ±0.03	25.55 ^d ±0.05
5	31.56 ^a ±0.03	26.54 ^c ±0.04	23.55 ^d ±0.06	29.56 ^b ±0.07
10	35.55 ^a ±0.05	35.56 ^a ±0.03	28.54 ^b ±0.08	25.65 ^c ±0.09
15	25.56 ^b ±0.06	30.56 ^a ±0.04	25.54 ^b ±0.05	24.54 ^c ±0.02
Viscosity (cp)*				
zero	763.0 ^d ±0.07	1041 ^a ±0.03	871 ^b ±0.05	796 ^c ±0.02
5	571.00 ^b ±0.05	507 ^c ±0.06	728 ^a ±0.08	481 ^d ±0.03
10	781.00 ^b ±0.09	651 ^c ±0.04	841 ^a ±0.02	582 ^d ±0.05
15	771.00 ^b ±0.03	631 ^c ±0.06	831 ^a ±0.08	571 ^d ±0.04

a,b ..Means in the same column are bearing different superscripts differ significantly (P<0.05).
J₁, J₂ and J₃ as indicated in Table (1), Cp= Centipoise

sample by increasing storage period. This increase in curd tension owing to the high content of TS and cold storage according to El-Shibiny *et al.*,(1977).

Generals the decrease in curd tension was owing to higher water holding capacity of the contained oligo and polysaccharides and fibers in JA extract. Also, as a result of proteolysis or lipolysis caused by the organisms and produced lactic acid, which increase acidity.

Bio-yoghurt viscosity fortified with Jerusalem artichoke extract at levels of 3, 5 and 7% JA extract also demonstrated in Table (2). Recorded data showed significant increase in viscosity of fresh Bio- yoghurt with increasing JA extract compared to the control sample and the treatment with 3% JA extract showed the highest value (10 41cp) followed by J₂ (871cp).

A higher decrease in viscosity was observed after 5 days of stored samples, then increased with in significance between differences among all treatments but significant in comparing with the control after 10 and 15 days except for the treatment J₂ that showed considerable increase and their values ranged from 871 to 831cp) which had the highest values and superior the con generally. There was no significant difference in the value of viscosity in treatment, during 5, 10 and 15 days of storage. Were illustrated in Table (6), there was a significant increase for the total viable bacterial count TVBC between the control and the treated sample with 3% JA extract and no Significance in difference with the sample contained 7% JA extract that recorded the same count (4×10^6 cfu/gm). The TVBC ranged from $4-13 \times 10^6$ for control and the sample 3% and from 4×10^6 for control and the sample 7%; meanwhile, the treatment J₃ void of this estimate.

Higher and significant increase in this population was revealed by the 5th day with control, which was gradually by increasing the added ratio of JA extract; this decrease significant and ranged from 25×10^7 cfu/gm for the control to for the sample containing 5% and the sample in 7% JAE. On the other hand, the TVBC of the control reused up to the storage period 10 days to be 18×10^7 to by increasing the added ratio of JAE to reach to 15 and the samples J₁ and J₂ then decreased to reach 18×10^7 for respectively. These results agreed with (Hashmi *et al.*, 2011. EL-Alfy *et al.*, 2012). 15 days of cold storage, the control sample showed increase in this estimate (22×10^7 cfu/gm) that gradually t the level of the samples J₂ and J₁ followed by J₃ giving for ($22, 18 \times 10^7$ and 14×10^7 cfu/gm) respectively. This result may be related the higher increase of molds and yeasts by increasing storage period.

In the same Table, the growth and viability of lactic acid bacteria showed higher and progressive increase as seen in the amples contained JA extract at levels of 3, 5 and 7% resulted in iighly significance between treated samples and the control than those of supplementing with TNM and gave the total counts ($58.75, 76.41 \times 10^8$ for the 3 and 5% treatments and then decreased significantly to reach 89.75×10^6 for the treatment 7% respectively This higher increase in this population may be related to the higher inulin content and other sugars as previously seen in this work. Molds and yeasts enumeration of Bio-yoghurt as affected by supplementing with JAE are registered in the same table. No numbers of these populations recorded in fresh samples as affected by higher heat of milk and the used ingredients and phenolic compounds contained in both Jerusalem artichoke.

Table (6): Total bacteria count, Total Lactic acid and Mold&Yeast(cfu/gm) of Bio-yoghurt supplemented with different levels of Jerusalem artichoke extract during storage period at 5⁰ C±1 storage temperature.

Treatments				
Storage period(days)	Control	J ₁	J ₂	J ₃
Zero	4 x 10 ⁶	13 x 10 ⁶	ND	13 x 10 ⁶
5	25 x 10 ⁷	14 x 10 ⁷	10 x 10 ⁷	10 x 10 ⁷
10	17 x 10 ⁷	22 x 10 ⁷	13 x 10 ⁷	18 x 10 ⁷
15	23 x 10 ⁷	18 x 10 ⁷	22 x 10 ⁷	15 x 10 ⁶
Total lactic acid	14.53 x 10 ⁶	58.75x10 ⁸	76.41x10 ⁸	89.75x10 ⁶
Mold				
Zero	ND	ND	ND	ND
5	1 x 10 ⁵	4 x 10 ⁵	ND	1 x 10 ⁵
15	2 x 10 ⁵	ND	2 x 10 ⁵	1 x 10 ⁵
Yeast				
Zero	ND	ND	ND	ND
5	1 x 10 ⁵	2 x 10 ⁵	2 x 10 ⁵	2 x 10 ⁵
15	2.5 x 10 ⁵	1 x 10 ⁵	0.5 x 10 ⁵	ND

ND=Not Detected, J₁=T₁, J₂=T₂, J₃=T₃ Zero=Fresh

Survival of molds and yeasts appeared and developed within the first week of cold storage with higher increase in total viable counts ranged from the treatment supplemented with This increase recorded 4x10⁵ for JA sample contained 3% -ict after 5days and the sample contained 7% equaled with the control the (1 x 10⁵) and not detected in the treatment with 5%.

Another increase was observed after 10 days of cold storage or the survival of molds and yeasts for the control sample, but showed decrease among treatments by the day 10th. At the same time, the molds not detected in the sample containing 3% JA react and not detected in samples containing 3% JA These results often related to the action of LAB on cots and other contained oligosaccharides producing acidity that hence growth of molds and yeasts.

Obtained data for Psychrophilic bacteria showed that it did not detect in Bio- yoghurt with supplemented with Jerusalem artichoke extract at different levels of supplementation or storage periods at 5±1°C and all their values were zero because of higher heat treatment of milk used in manufacture of the produced Bio-yoghurt and phenolic compounds contained in both tubers which act as antimicrobials and antioxidant.

From Table (7), it could be observed that addition Jerusalem artichoke extracts improved the flavor of resultant -yoghurt compared to control at zero time, which scored 9.25 and 9.65, respectively. Yoghurt samples, treated by 5% JA had the highest scores color, flavor, appearance, texture and overall acceptability compared to yoghurt control, which recorded (9.82, 9.62, 9.62). and 9.65 , 9.44, 9.25, 9.26, 8.25 and 8.97 respectively.

Table (7): Sensory evaluation of Bio-yoghurt supplemented with different levels of Jerusalem artichoke extract during cold storage.

Storage period(days)	Color			
	Control	J ₁	J ₂	J ₃
Zero	9.44 ^b ±0.02	9.82 ^a ±0.04	9.82 ^a ±0.03	9.82 ^a ±0.02
5	9.09 ^b ±0.03	8.70 ^c ±0.05	9.15 ^a ±0.06	8.03 ^c ±0.07
10	7.88 ^d ±0.08	9.06 ^a ±0.03	8.47 ^b ±0.09	8.00 ^b ±0.07
15	7.20 ^c ±0.04	8.55 ^a ±0.07	8.09 ^b ±0.03	8.03 ^b ±0.02
Flavour				
Zero	9.25 ^b ±0.07	9.60 ^a ±0.05	9.62 ^a ±0.04	9.65 ^a ±0.06
5	8.49 ^b ±0.03	7.38 ^d ±0.06	8.70 ^a ±0.04	8.12 ^c ±0.07
10	7.50 ^d ±0.05	8.37 ^a ±0.03	8.23 ^b ±0.04	8.04 ^c ±0.02
15	7.03 ^b ±0.06	8.10 ^a ±0.07	8.06 ^a ±0.05	8.00 ^a ±0.03
Appearance				
Zero	9.26 ^b ±0.09	9.61 ^a ±0.07	9.62 ^a ±0.03	9.63 ^a ±0.07
5	8.55 ^b ±0.05	8.24 ^c ±0.04	8.85 ^a ±0.06	8.35 ^b ±0.03
10	7.03 ^d ±0.07	8.86 ^a ±0.03	8.38 ^b ±0.09	8.09 ^c ±0.02
15	7.01 ^c ±0.08	8.52 ^a ±0.02	8.03 ^b ±0.07	8.00 ^b ±0.05
Texture				
Zero	8.25 ^c ±0.08	9.62 ^a ±0.04	9.44 ^b ±0.06	9.40 ^b ±0.07
5	8.27 ^a ±0.06	7.85 ^c ±0.03	8.25 ^a ±0.05	8.00 ^b ±0.02
10	6.87 ^d ±0.07	8.63 ^a ±0.02	8.37 ^b ±0.04	7.87 ^c ±0.08
15	6.60 ^c ±0.08	8.10 ^a ±0.02	8.03 ^a ±0.04	7.40 ^b ±0.09
Overall Acceptability				
Zero	8.97 ^c ±0.05	9.65 ^a ±0.03	9.58 ^b ±0.07	9.57 ^b ±0.06
5	8.41 ^b ±0.09	8.44 ^b ±0.08	8.72 ^a ±0.05	8.13 ^c ±0.03
10	7.33 ^d ±0.02	8.66 ^a ±0.05	8.28 ^b ±0.03	8.11 ^c ±0.04
15	7.07 ^d ±0.03	8.65 ^a ±0.09	8.02 ^b ±0.09	8.06 ^c ±0.04

a,b ..Means in the same column are bearing different superscripts differ significantly (P<0.05).

,J1, J2 and J3 as indicated in Table (1). ND: not detected

On the other hand, storage period effect in all sensory characteristics by decreasing, which was higher in control Bio-yoghurt than other treated samples by different level of JAECially after 15 day of storage at 5°C.

Statistical analysis revealed significant increase in scored values obtained by panelists for Bio-yoghurt color of fresh treated Tuples with JA extract at level of J1 (9.82), J2 (9.82) and J3 (9.82)degree supersizing the control sample (9.44). Regularly flavor and overall acceptability at zero time of manufacture saved the same behavior scoring the highest numbers comparing with the count

Conclusively, from these results, it could be concluded that supplementation dairy products with Jerusalem artichoke as treatment for diabetes. Because if it was approved that it reduces the level of glucose in blood, because they contain many vitamins and nutrients necessary and beneficial to human health.

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تدعيم الزبادي الحيوي باستخدام الطرطوفة كمصدر طبيعي

اشرف شعبان طه* - محمد عرفة محمد موسى** - امينة محمد مختار الشهاوى**
 *كلية الزراعة جامعة طنطا قسم علوم وتكنولوجيا الاغذية (ألبان)
 **معهد بحوث الانتاج الحيواني مركز البحوث الزراعية وزارة الزراعة مصر

تم استخدام درنات الطرطوفه في تدعيم الزبادي الحيوي المنتج باستخدام البروبيوتك لزياده القيمة الحيوية والفوائد الصحية وكذلك تحسين الخواص الريولوجية والفيزيوكيميائية والحسيه للمنتج النهائي.

حيث تم تصنيع زبادي حيوي من اللبن البقري بالطريقة التقليدية مع تدعيمه بمستخلص مسحوق الطرطوفه بنسب (T₁ 3%-T₂ 5%-T₃ 7%) وتم تحليل المنتج خلال التخزين على درجه حراره 5±1° لمدة 15 يوم. وقد اوضحت النتائج المتحصل عليها زياده محتوى الرطوبة في المعاملات بزياده معدلات الإضافة من مستخلص مسحوق الطرطوفه حتى النسبة 7% ولم يظهر تأثير معنوي على محتوى البروتين والرماد والدهن بزياده نسب التدعيم كما اوضحت النتائج انه وجد زياده معنويه فى محتوى الالياف فى كل المعاملات المدعمة بالمقارنة بالكنترول وقد اظهرت النتائج المتحصل عليها ان الجوامد الصلبة تقل بصوره غير معنويه بزياده معدلات اضافة مسحوق درنات الطرطوفه خلال التخزين - كما اوضحت النتائج المتحصل عليها تفوق المعاملة (T₃) 7% من المسحوق ثم المعاملة (T₂) 5% مقارنة بالكنترول من مجموع الاحماض الأمينية الأساسية على الترتيب وتوقت العينة المحتوية على 5% مسحوق تليها العينة المحتوية على 3% ثم العينة المحتوية على 7% فى محتواها من الاحماض الأمينية الغير اساسيه مقارنة بالكنترول. وقد اوضحت النتائج ان المعاملة T₂ المدعمة بنسبه 5% احتوت على اعلى نسبة من فيتامين B₃ وزاد معدل التشریش بزياده معدل الإضافة حتى 7% مقارنة بالكنترول ونتيجة للمعاملة الحرارية لم يظهر أي تأثير للخمائر والفطريات وقد لوحظ ان فتره التخزين اثرت تأثير دقيق على الخواص الحسيه للزبادي الحيوي. المعاملات المدعمة ب5% مسحوق طرطوفه سجل اعلى خواص حسيه مقارنة بباقي المعاملات والكنترول.

التوصية: بناء على النتائج المتحصل عليها من البحث فانه ينصح باستخدام الطرطوفه في تدعيم منتجات الالبان كغذاء وعلاج لمرضى السكر لما ثبت انها تعمل على تخفيض نسبه السكر في الدم وكذلك لاحتوائها على الكثير من الفيتامينات والكثير من العناصر الغذائية المهمة و اللازمة لصحة الانسان .