J.Agric.Chem.and Biotechn., Mansoura Univ.Vol. 6 (8): 261 - 283, 2015

EFFECT OF *Jerusalem artichoke* AND *Tigernut* AS SUGAR SOURCES ON PATHOGENIC and PROBIOTIC BACTERIA GROWTH IN SOME FUNCTIONAL FOOD (BIO - YOGHURT AND WHEAT DOUGH)

El – Reffaei, W. H. M.; A. F. Abdel – Salam; A. M.M. El-Kharamany and Eman M. Ragheeb

Regional Center for Food and Feed (RCFF), Agric. Res. Center, Giza, Egypt.

EFFECT OF *Jerusalem artichoke* AND *Tigernut* AS SUGAR SOURCES ON PROBIOTIC GROWTH IN SOME FUNCTIONAL FOOD (BIO-YOGHURT AND WHEAT DOUGH)

El-Reffaei, Wael W. H. M. El-Reffaei, Ahmed F. Abdel – Salam, Adel A. M.M. El-Kharamany and Eman M. Ragheeb

Regional Center for Food and Feed (RCFF), Agric. Res. Center, Giza, Egypt.

ABSTRACT

In recent time, there has been an increase interest to improve prebiotic material and probiotic bacteria mainly in food. This study aims to evaluate the effect of *Jerusalem artichoke (JR)* and *Cyprus esculents* (Tigernut or Chufa) (TN) as prebiotics source, in to improve growth and survival of probiotic bacteria in yoghurt and as a preserved agent against the food borne bacteria *in vitro*. In addition, emphasis on improve nutritional value of dough using a new source of inulin by supplemented wheat flour with *JR* and *TN*. In *vitro* JR and TN were used as prebiotic for evaluation their effect as growth promoters for prebiotic bacteria (*Lactobacillus plantarum*, *Lactobacillus curvatus* and *Bacillus subtilis*) and evaluated antimicrobial activity against *Staphylococcus aureus* at different concentrations (5.0 and 10.0%). The results revealed that JR and TN contained of a sufficient amount of macronutrients carbohydrate, fiber and valuable amino acids. Sugar profile of these plants showed that, inulin was the most abundant polysaccharides in JR while TN is was abundant in fructose. These polysaccharides (inulin and fructose) as considered as bioactive ingredients and prebiotic compounds. In addition, 10 % supplementation level of JR or TN resulted in greater growth rates of prebiotic bacteria, as well as showed stronger antimicrobial activity. Therefore, these results could suggest a preferential utilization of *JR* and *TN* in the people diet for improving the nutritional value and provide health benefits as functional foods, as well as considered economic and natural antimicrobial agent in food preservation.

Key words: *Jerusalem artichoke*, Tigernut, Inulin, Yoghourt, Wheat dough, Prebiotic, Antimicrobial,

INTRODUCTION

Probiotic foods including dairy products defined as food containing live microorganisms, which believed to enhance health by improving the balance of microflora in the jut (Tamime *et al*., 2005). The microorganisms that most commonly used as probiotics belong to the heterogeneous group of lactic acid bacteria and the genius Bifidobacterium. Prebiotics are non-digestable components of functional food that stimulate the proliferation and activating of bacterial population desirable in the colon and inhibit pathogen multiplication, hence beneficially acting on the host (Mattila *et al*., 2002). The most important prebiotics are fructans (inulin and oligofructoses), glucans and mannans, which are soluble and fermentable fibers (Gibson *et al*., 2004).

Formatted: Fontcolor: Black
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted: Centered
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted

Supplementation of skim milk with inulin, even at a low concentration significantly improves the growth and viability of *Lactobacillus acidophilus*, *Lactobacillus rhamnosus* and *Bifidobacterium lactis* (Cruz *et al*., 2010 and Oliveria 2011). Inulin is among the most famous prebiotic compounds. Also when inulin added to the food in low concentrations the rheological properties and sensory quality of the product improve (Aguilar *et al*., 2015). *Cyperus esulentus*, root stock snack or earth almond is among the popular, cheap and sweet convenience foods in Africa. It has been cultivated since the fourth millennium BC in Egypt, and for several centuries in Southern Europe. It is a perennial tuber commonly found in Egypt. The major components of this tuber are complex carbohydrates. It is comprise fructosyl-fructose linked compounds such as inulin. In human nutrition intervention trials, inulin appeared to be more effective than oligofructose in reducing triglyceridemia, whereas in animals (especially in rats), both products were equally active. In the high fat diet HF and the diets, containing inulin delayed the lowest plasma triglyceride and total cholesterol levels (Reimer and Russell 2008). In young adolescents, daily consumption of a combination of prebiotic short- and long-chain inulin-type fructans significantly increases calcium absorption and enhances bone mineralization during pubertal growth. Effects of dietary factors on calcium absorption may be modulated by genetic factors, including specific vitamin D receptor gene polymorphisms (Abrams *et al.* 2005).

Among other plants rich inulins is *Jerusalem artichoke* (*Helianthus tuberosus L.*) (JR), its tuber accumulates similar levels of inulin (10-20 %) of fresh tuber). Therefore, this study aims to evaluate effect of JR and TN as prebiotics source in fermented dairy products and assess their antimicrobial effect. In addition, improve nutritional quality of bake product by new source of fructosan.

There is a strong relationship between food and medicine so that in many cases, the food use is not separable from its medicinal action, a specific association between foods/nutrients and health functions, consumers clearly believe in the concept of functional nutrition (**Pieroni, 2003)**. Prebiotic foods including dairy products defined as "foods containing live microorganisms, which believed to enhance health by improving the balance of micro-flora in the gut" (**Tamime *et al*., 2005**). The microorganisms that most commonly used as probiotics belong to the heterogeneous group of lactic acid bacteria as (*Lactobacillus*, *Enterococcus*…etc) and to the genus *Bifidobacterium* (**FAO/WHO, 2001**). Foods containing such bacteria fall within the category of functional foods, which described as foods claimed to have a positive effect on health. Probiotics are able to be effective in the treatment of several intestinal disorders and have an impact on the immune system (**Foligne *et al*., 2007**). *Lactobacillus casei Shirota* fermented milk enhances cytotoxic activity of natural killer cells (**Takeda *et al*., 2006**), and lactic acid bacteria play a beneficial role in the ecosystem of the human intestinal tract (**Jia *et al*., 2008**). Furthermore, consumption of probiotic products is helpful in maintaining good health, restoring body vigor and skirmishing intestinal and other diseases. Probiotic is considered as a functional ingredient because it is not absorbed in the small intestine and exerts a prebiotic effect on the intestinal habitat, which causes normalization of stool frequency (increases

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Left-to-right

Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: 10 pt, Complex Script Font: 10 pt

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: 10 pt, Complex Script Font: 10 pt

Formatted: Font: 10 pt, Not Bold, Not Italic, Complex Script Font: 10 pt, Not Bold, Not Italic

Formatted: Font: 10 pt, Complex Script Font: 10 pt

Formatted: Font: 10 pt, Not Bold, Not Italic, Complex Script Font: 10 pt, Not Bold, Not Italic

Formatted: Font: 10 pt, Not Bold, Complex Script Font: 10 pt, Not Bold

Formatted

Formatted

Formatted

Formatted

Formatted

Formatted

Formatted: Left-to-right

Formatted

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Normal, Justify Low

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

the number of bacteria and/or activity of the number of *bifidobacteria* and lactic acid bacteria in the human gut) (**Rodrigues *et al.*, 2011**). Thus, probiotic bacteria offer new dietary alternatives for the management of such conditions through stabilization of intestinal microflora, promotion of colonization resistance, regulation of the immune response and preservation of intestinal integrity (**Farnworth, 2008**).

Fermented dairy products have been the most utilized food matrix for probiotic intake. Several studies have related the promising health benefits of consuming culture containing milks. *Lactobacilli* (*Lactobacillus* and *Bifidobacterium spp*.) (LAB) are important inhabitants of the intestinal tract of men and animals and are involved in a number of potential health beneficial roles viz., immune modulation, pathogen exclusion, production of antimicrobial substances, anticarcinogenic and cholesterol lowering activities (**Farnworth, 2008**). Furthermore, LAB strains synthesize short chain fatty acids, vitamins, and exopolysaccharides (EPS) that employed in the manufacturing of fermented milk to improve its texture and viscosity (**Ruas-Madiedo *et al.*, 2002**). Studies have proven the successful incorporation of probiotics into yogurt as well as other fermented milk products; such as, soy yogurt (**Farnworth *et al.* 2007 and Hekmat *et al.*, 2009**). The ability of probiotic bacteria (*Lactobacillus acidophilus* La5 and *Bifidobacterium animalis* Bb12), to produce conjugated linoleic acid (CLA) in association with *Streptococcus thermophilus* and *L.b. bulgaricus* during milk fermentation has been evaluated in this study by **(Manzo *et al.*, 2015).** CLA contents of 10 commercial fermented milk products were determined. The highest content has observed in fermented milk containing only Str. thermophiles and *Lb. bulgaricus*.

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Chufa, *Cyperus esulentus*, root stock snack or earth almond, commonly called "Tigernut, (TN) belongs to the genus *Cyperaceous;* it is among the popular, cheap and sweet convenience foods in Africa. It has been cultivated since the fourth millennium BC in Egypt, and for several centuries in Southern Europe. It is a perennial tuber commonly found in Egypt and Spain, as well as, in some other countries around the Mediterranean region (**Coskuner *et al.*, 2002**). The spherical underground tubers are edible and have a sweet nutty flavor, it consume fresh, dried or roasted, and recorded as having medicinal properties (**Negbi, 1992 and Barminas *et al.* 2001**). The major components of this tuber are complex carbohydrates. It is comprise fructosyl-fructose linked compounds such as inulin, which are associated with several physiologic actions in the small and large intestine, thus showing several important metabolic implications for health (**Roberfroid, 2001**). Its protein content is rich in arginine, which liberates hormones that produce insulin; thus being suitable for diabetics (**Adejuyitan, 2011**), furthermore minerals (phosphorus and potassium), vitamins (Vit E and C), steroids and triterpenes thus making this tuber suitable for diabetics. It has reported to be a health food, since its consumption can prevent heart disease, thrombosis, activate blood circulation and reduce the risk of colon cancer (**Frega *et al.*, 1984 and Arafat *et al.*, 2009 and Chukwuma *et al.*, 2010**). Tigernut`s oil known for its high-unsaturated fatty acid contents and thus can be useful for human

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Left-to-right

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic

nutrition in replacing conventional sources of oil (**Makai and Balantincz, 2002**). This tuber commonly used for the production of milk, nonalcoholic beverages, and used as food additives and spices (**Umeri and Enebeli, 1996**).

Prebiotics are non-digestible components of functional food that stimulate the proliferation and activity of bacterial population desirable in the colon and inhibit pathogen multiplication, hence beneficially acting on the host (**Roberfroid, 2000 and Marttila *et al.*, 2002**). The most important prebiotics are fructans (inulin and oligofructoses), glucans and mannans, which are soluble and fermentable fibers (**Gibson *et al.*, 2004**). It not digested by α-amylase or other hydrolases in the upper section of the intestinal tract (**Carabin and Flamm, 1999 and Piad *et al.*, 2006**). In human nutrition intervention trials, inulin appeared to be more effective than oligofructose in reducing triglyceridemia (**Reimer and Russell, 2008**). In young adolescents, daily consumption of a combination of prebiotic short- and long-chain inulin-type fructans significantly increases calcium absorption and enhances bone mineralization during pubertal growth (**Abrams *et al.*, 2005**). Oligosaccharides suppress potentially deleterious bacteria among the gastrointestinal microbiota (**Kajawara *et al.*, 2002**). Increase in the number of beneficial *Bifidobacterium spp.* in the intestinal microbiota has been the mean focus of prebiotic addition (**Akalin *et al.*, 2004 and Gibson *et al.*, 2004**). **Oliveria (2011)** demonstrated that, supplementation of skim milk with inulin, even at a low concentration significantly improves the growth and viability of *Lactobacillus acidophilus*, *Lactobacillus rhamnosus* and *Bifidobacterium lactis* **(Akin *et al.*, 2007 and and Cruz *et al.*, 2010).** Among other plants rich inulins is *Jerusalem artichoke* (*Helianthus tuberosus L.*) (JA), its tuber accumulate similar levels of inulin (10-20 % of fresh tuber) as chicory roots (**Frank, 2000**) and could be cultivated at a low cost with low input of fertilizers on any type of soil and cool climatic conditions (**Parameswaran, 1994**). However, the use of JA tubers for inulin extraction is less well known as they are commonly eaten as vegetable. When inulin added to food in low concentrations the rheological properties and sensory quality of the product not be affected strongly due to the neutral or slightly sweet taste and the limited effect on the viscosity of this ingredient (**Kalyani *et al.*, 2010**).

Akalin *et al.* (2007) study conducted to stimulate the growth of probiotic bacteria during yoghurt fermentation and to improve their survival until the use - by-date, by supplementing yoghurt milk with growth factors such as vitamin enriched protein hydrolsate, amino nitrogen and whey protein concentrate. Co-culturing with proteolytic yoghurt bacteria i.e. *Lactobacillus delbrueckii subsp. Bulgaricus* (LB) and *Streptoccus thermophilus* (ST) also enhances the growth and the viability of probiotics and helps to reduce fermentation time **(Dave and Shah, 1998)**. **Donker *et al.* (2007)** demonstrated that, supplementation of yoghurt with inulin at low concentration significantly improves the growth and viability of *Lactobacillus acidophilus* and *Lactobacillus casei* used as probiotics in yoghurt during cold storage. Therefore, inulin appears an important food ingredient that would merit to be additionally explored for the production of functional foods.

Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold

Formatted: Left-to-right

Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold

The yoghurt containing inulin had stable color and water activity and synergensis did not prevail during strong, being similar to the other dietary-fiber containing yoghurt (**Staffolo *et al.*, 2004**). **Pimentel *et al.* (2013)** reported that, addition of long chain inulin in low fat yogurt could lead to interesting results in sensory properties especially in texture characteristics. In particular, replacement of native milk fats with long chain inulin created equally acceptable firmness and color as with yogurt containing native milk fats. Most of the characteristics of the final product and the process remain fairly close to the values of the originals. Several short chain prebiotics have a slightly negative effect on the firmness and creaminess of the yogurt whereas long chain prebiotics increase those values. Overall, the final choice remains with the consumer and their preference for texture.

Substitutions of wheat flour by non-wheat flour led different in satisfying bread products. However, composite wheat breads generally displayed reduction in loaf volume and impairment of sensory qualities (e.g. appearance, texture, and flavor), as the level of substitution of wheat with non-wheat flour increased (**Peressini and Sensidoni, 2009**). Due to the fact that the main selection criteria of wheat are based on their ability to give bulky white breads, it appeared useful to seek products of substitution that had less negative impacts on the volume of the bread. Therefore, it is necessary to have a low content of ashes in the composite flours of cereals or roots used in bread-making process to obtain bread with a pleasant crumb color and taste (**Zhang and Moore, 1997**). Tiger nut flour could be used in bakery products (**Chinma *et al.*, 2010**) as well as to formulate gluten-free bread with good baking and nutritional characteristics (**Aguilar *et al.*, 2015**). Bread elaborated with both chickpea and tiger nut flour maintained its baking characteristics (bake loss, specific volume, crust and crumb color and, crumb hardness) even when shortening and/or emulsifier were reduced or eliminated (**Aguilar *et al.*, 2015**). Continued increasing interest lies with the polysaccharide inulin. This is due to its nutritional properties and functional abilities. It has been widely utilized as a processing ingredient due to its bulking ability, structure-forming capacity, water retention, and its ability to improve rheological properties and stabilize emulsions and foams (**Juszczak *et al.*, 2012**).

Clinical trials indicate that viscous soluble fiber is more effective than cereal fiber in lowering serum cholesterol (**Kendall *et al.*, 2010**). Moreover, dietary intake of viscous fiber has a hypoglycemic effect (**Landin *et al.*, 1992**). **Polaki *et al.* (2010)** and **Demirkesen *et al.* (2013)** investigated the effects of using TN flour in a gluten-free formulation in comparison to a rice bread control, the use of tigernut decreased bake loss, increased specific volume, and decreased firmness of the resulting breads when incorporated at the optimal level (10:90/ tigernut: rice). Furthermore, the high level of fat present in TN (20.5%) generated a plasticizing effect on the rheological and proofing properties of the dough, resulting in enhanced crumb structure and bread volume. Inulin is among the most famous prebiotic compounds. In order to improve viability of probiotic bacteria during storage, fermented food should be supplemented with prebiotics. Therefore, this study aims to

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Normal, Justify Low

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Justify Low, Line spacing: single

~~evaluate effect of JR and TN as prebiotics source in fermented dairy products and assess their antimicrobial effect. In addition, improve nutritional quality of bake product by new source of fructosan.~~

MATERIALS AND METHODS

Preparation of samples:

Jerusalem artichoke (JR) was kindly obtained from farm from Sharkia Egypt. Brown *Cyperus esculents* (tigernut tubers or Chufa) (TN~~),~~) was bought from local market (Sharkia Egypt~~),~~). TN they screened on a metallic sieve in order to calibrate them according to their average diameter ~~(two~~(two sieve sizes were used 1 and 0.5 cm), then washed with tap water to remove sands and other undesirable materials. Also *Jerusalem artichoke* was ~~,~~ ~~slicing~~sliced cutting (think 0.5 cm) and dried on oven drying at 50 °C until dry, then ground into flour using attrition mill (Globe ~~P44,~~ China) and~~). The flour samples were~~ passed through a 0.45 mm mesh size sieve, ~~. It was then~~ packaged in an airtight polyethylene bag and stored in a plastic container with lid and then stored in a freezer at -18 °C until analysis.

Soaking experiments:

Soaking experiments on TN were conducting according to Turhan *et al.* (2002). ~~400 ml distilled water put in b~~Beakers (500 ml~~),~~) containing 400 ml distilled water ~~which~~ were placed in a constant temperature water bath at 25 °C. During soaking, tubers periodically removed, superficially dried with a tissue paper. The experiment was terminated when tuber moisture content attained an equilibrium value, i.e., when the increment change in sample weight was less than 0.01 g. At least three experiments conducted for every tiger nut diameter at soaking temperature. After soaking TN was drained, rinsed, and ground into flour using attrition mill (~~Globe~~ Globe~~P44,~~ China). The flour samples were passed through a 0.45 mm mesh size sieve. It was then packaged in an airtight polyethylene bag and stored in a plastic container with lid and then stored in a freezer at) - 18 °C from where samples were taken for analysis.

Chemical composition of ~~JA~~ JR and TN:

Fat, protein, ash, moisture and fiber contents were determined by AOAC (2012), while carbohydrates were obtained by difference.

Determination of amino acids (AA):

It performed according to method described in AOAC (2012). Samples were analyzed for AA using Amino Acid Analyzer (BIOCHROM 30, serial 103274, with EZ chrom manual 2004), software used for data collection and processing. The results performed by percentage of total crude protein. Determination of tryptophan carried out using method described by Miller (1967) after hydrolysis of samples with barium hydroxide.
The predicted protein efficiency ratio (P-PER) was calculated using the equation according to Alsmeyer *et al.* (1974): P-PER = -0.468 + 0.454(Leu) – 0.105(Tyr)

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted: Left-to-right
Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Font: 9 pt, Complex Script Font: 9 pt
Formatted: Left-to-right

Determination of fatty acids of plants and bio-yoghourts:

~~Fatty acid profile of the plants and bio-yoghourts, s~~Samples of each were dried at 60 °C and ground in a coffee grinder to a particle size of approximately 1 mm^3. Fats were extracted from the samples with petroleum ether (60-80 °C boiling fraction) in a Soxtec apparatus (FOSS Tecator, Auckland, NZ). Fatty acids in the extracted oils were esterified by BF_3 and methanol into fatty acid methyl esters (FAMES) according to described method of AOAC (2012). The fatty acid methyl esters analyzed by gas liquid chromatography (Shimidazu GC 2010) using DB-wax column. The carrier gas was ~~N2~~ Helium with a flame ionization detector, fatty acids identified according to standard FAME.

Determination of polysaccharides:

Determination of polysaccharides in JR was done using the method of (Cabezas *et al.*, 2002), 4 grams of sample were dissolved in HPLC grade water sonicated for one hour, centrifuged for 10 min at 4000 Xg, the supernatant were quantitive transferred to measuring flask 100 ml and completed to the mark HPLC grade water sonicated again for 15 min, then poured through 0.20 µm membrane filter. While in TN, using described method by Mano *et al.* (2009) and Helle *et al.* (2010), was used 1 g of sample were dissolved in HPLC grade water sonicated for one hour, centrifuged for 10 min at 4000 Xg the supernatant were quantitate transferred to measuring flask 100 ml and completed to the mark HPLC grade water sonicated again for 15 min. Poured through 0.20 µm membrane filter completed to volume with acetonitrile. Chromatographic analysis of the sugars in JA and TN were determined by HPLC, fitted with RI detector, column typr Rezex 300× 7.8 mm, at 80°C, flow rate 0.6 ml /min with water 100% as mobile phase according to Javier *et al.* (2011).

Determination of vitamins:

Vitamin B1 (thiamine), B2 (riboflavin) were measured as described by Bognar (1992), Beckman HPLC , injector and data handling item Perkin-Elmer flourencece detector LC240 and C18 column 25cm × 4.6 mm were used. Vitamin E (α–tocopherol) was measure by using HPLC according to AOAC (2012), determination was done by using isopropanol n-heptane, Spectrophotometer detection at 285 nm. Vitamin C was assessed according to the method of Campos *et al.* (2009), briefly homogenized samples (about 1 g) were added to 15 ml of extraction solution (3% metaphosphoric acid, 8% acetic acid, 0.3 N sulfuric acid and 1 m M EDTA). After filtrate under vacuum, it diluted in ultrapure water and ~~adjust~~adjusts the volume to 25 ml, then centrifuged at 1789 g for 15 min. The supernatant was stored in a refrigerator at 5 °C and analysis by using HPLC.

Determination of minerals:

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Normal, Justify Low

Formatted: Justify Low, Line spacing: single, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: Justify Low, Line spacing: single

... rmatted

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Justify Low, Indent: First line: 0.95 cm, Line spacing: single, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers

Formatted: Justify Low, Line spacing: single

... rmatted

Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold

Formatted: Justify Low, Indent: First line: 0.95 cm, Line spacing: single

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Justify Low, Line spacing: single

... rmatted

Formatted: Justify Low, Indent: First line: 0.95 cm, Line spacing: single, Adjust space between Latin and Asian text, Adjust space between Asian text and numbers

Formatted: Justify Low, Line spacing: single

Mineral contents in JR and TN identified as described by AOAC (2012). The minerals were determined by digesting 0.5 g sample in concentrated HNO_3 at a temperature of 85 °C and then in $HClO_4$ at temperature of 180 °C until 1-2 ml of digested samples left. The digested samples then filtered and volume made up to 25 mL. These samples run through an Atomic Absorption Spectrophotometer (Varian, AA240, and Victoria, Australia) using air acetylene flame to determine the minerals content.

Extraction and identification of compounds by GC–MS in methanol extract:

The GC–MS instrument used to separate and detect methanol extracting JA and TN according to the method described by Boskou (2005) and AOAC (2012). One gram of flour was extracted three times with methanol l2 ml. The extracted combined and methanol evaporated under reduced pressure. The residue was dissolved in acetonitrile (2ml) and washed two times with hexane (3ml). Acetonitrile evaporated under vacuum and the residue dissolved in methanol (1ml). Injections of 10µl from this dissolve-extracted lipid in methanol were performed using a GC/MS (Agilent Technologies 6890N computerized system coupled to an MSD, Agilent 5973B mass spectrometer).

Preparation of bio-yoghurt:

The bio-yogurt samples were made from cow milk and prepared as described by Shori and Baba (2011). Samples divided into five groups (100 ml milk /each), ~~JA~~ JR and TN flours added at 10%. Each of five groups mixtures placed in a glass jars and heated at 85°C for 30 min, then allowed to cool (40 ~~–~~ 42 °C), subsequently inoculated with *Lactobacillus plantarum* and *Lactobacillus curvatus* bacterial cultures at 40°C and fermented until pH 5.7. After incubation, yoghurts were stored in 4°C and examined in order to check the growth of lactic acid bacteria.

Texture profile analysis (TPA):

It was determined by a universal testing machine (Cometech, Btype, Taiwan) provided with software. An Aluminum 25 mm diameter cylindrical probe was used in a TPA double compression test to penetrate to 50% depth, at 1 mm/s speed test. Hardness (N), gumminess, chewiness, adhesiveness, cohesiveness and springiness calculated from the TPA graphic. Firmness (N); maximum force required to compress the sample (was determined as the maximum penetration and expressed in yoghurt), Cohesiveness; extent to which sample could be deformed prior to rupture, Springiness; ability of sample to recover to its original shape after the deforming force was removed, Gumminess; force to disintegrate a yoghurt sample for swallowing (hardness × Cohesiveness) and Chewiness; work to masticate the sample for swallowing (springiness × gumminess) were determined as described by Bourne (~~2003~~2002).

Organoleptic properties:

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted: Left-to-right
Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, Complex Script Font: Arial
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Justify Low, Indent: First line: 0.95 cm, Line spacing: single
Formatted: Justify Low, Line spacing: single
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted: Left-to-right
Formatted

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Normal, Justify Low

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Justify Low, Line spacing: single

Organoleptic properties of bio-yogurt was running after 1 day of refrigerated storage. Ten untrained panels' participants selected randomly for sensory evaluation. Each panel tested two types of bio-yogurt one fortified yogurt with ~~biofedobacterium~~ biofidobacterium and ~~JA~~ JR and second fortified yogurt with biofedobacterium and TN. The evaluation was scored on 1–10 point hedonic scale (1-2 = extremely poor, 3- 4 = poor, 5-6 = fair, 7- 8 = good, 9-10 = excellent) according to taste sour, bitter, sweet, aroma and overall acceptability.

Formatted: Justify Low, Indent: First line: 0.95 cm, Line spacing: single

Formatted: Justify Low, Line spacing: single

Rheological properties of dough by Alveograph:

White wheat flour used as control (~~100~~72% ~~white wheat flour~~extraction ratio), ~~JA~~ JR and TN /wheat flour blends were prepared at 5%, 10% and 15% of white wheat flour substitutions and wheat. Rheological properties are maintained by Alveograph to determine the quality of wheat flour blends with ~~JA~~ JR and TN according to AACC (2000) method No (AACC 54-30A). Each Alveograph result was analyzed for the following parameters: Tenacity (P) mm H_2O : the maximum over pressure needed to blow the dough bubble, expresses dough resistance; Extensibility (L) mm : the length of the curve, expresses dough extensibility, Configuration rate (P/L) % : the configuration ratio of the Alveograph curve, Index of swelling (G): index of swelling, Baking strength or (deformation energy (W)10E-4 J: baking strength (surface area of the curve), Elasticity index (Ie) %: elasticity index.

Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Microbiological evaluation:

Bacterial strains:

Each *Lactobacillus plantarum* code no . (ATCC14917) and *Lactobacillus curvatus* code no. (1136T) strains were obtained from Microbiological Resources Center (Cairo MIRCEN), faculty of Agriculture, Ain Shams University. *Staphylococcus aureus* code no (A.F 15) and ~~*bacillus*~~ *Bacillus subtilis* strains were kindly provided by Dr. Ahmed F. Abdel Salam ~~from ,~~ Regional Center for Food and Feed, Agriculture Research center, Giza, Egypt).

Isolates maintaining:

Each *L. plantarum* and *L. curvatus* isolates were maintained through monthly transfer on MRS agar, while *Staph aureus* and *Bacillus subtilis* (*B. subtilis*~~*sub*~~) isolates were maintained through monthly transfer on nutrient agar. All strains were stored at 4 °C.

Standard ~~inoculums~~inoculants:

Formatted: Font: (Default) Arial, 10 pt, Italic, Complex Script Font: Arial, 10 pt, Italic

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, 10 pt, Not Italic, Complex Script Font: Arial, 10 pt, Not Italic

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Standard ~~inoculums~~ inoculants were prepared by inoculation of conical flasks (100 ml in volume containing 50 ml of MRS broth pH 5.7) for 24 at 30 °C with loop of *L. plantarum* or *L. curvatus* isolates and another flask containing 50 ml of nutrient broth (pH 6.8) for 24 hr at 30 °C with a loop of *Bacillus subtilis,* beside flask containing 50 ml of buffered peptone water (pH 7.2) for 24 hr at 37°C with loop of *Staph aureus.* Achieve viable cells count were determined by serial dilution and subsequent enumeration on MRS agar for *L. plantarum* and *L. curvatus*, nutrient agar for *Bacillus subtilis* and Vojel Johnson agar for *Staph aureus*. Plant substances of ~~JA~~ JR and TN were

prepared at different concentrations (5.0 and 10.0 %) and tested as growth promoter for *L. plantarum* and *L. curvatus* activity against *Staph aureus.*

Effect of JR and TN on probiotic bacteria strains in *vitro*:

Erlenmeyer flasks (250 ml) contained 50 ml of MRS broth were inoculated with 1 ml of *L. plantarum* or *L. curvatus* inoculum containing about 10^{13} cfu/ml, then added different concentrations (5.0 and 10.0 %) of JA JR or TN were added to the flask separately, which incubated at 30 °C for 24 hr on rotary shaker (100 rpm). Moreover, flasks contained 50 ml of nutrient broth (pH 6.8) were inoculated with 1 ml of *Bacillus subtilis* inoculum containing about 10^{11} cfu/ml and flasks contained 50 ml of brain heart infusion broth (pH 7.4) were inoculated with 1 ml of *Staph aureus* inoculum containing about 10^{13} cfu/ml then added different concentrations (5.0 and 10.0 %) of JA JR or TN were added to the flask separately, which incubated at 30 °C for 24 hr on rotary shaker (100 rpm). The control inoculated without any treatment for each bacterial strain at the same experimental condition.

Antimicrobial effect of JA or TN:

Yoghurt samples five treatments as follow control, second and third containing JAJR, fourth and fifth containing TN at 5.0 and 10.0 % of, respectively. All samples inoculated with *Staph aureus* (about 10^{13} cfu/ml) and inoculated at 37 °C for 3hr, then put at 4°C, the mean cfu/ml for *Staph aureus* was determined according to (Berrang *et al.*, 2001).

RESULTS AND DISCUSSIONS

Chemical composition of JA JR and TN:

The nutrients and proximate analysis of JR and TN are presented in (Table 1). Results revealed that, JR and TN were contained carbohydrate 78.00 and 41.22 % , crude fat 0.38 and 35.43% , ash 5.22 and 4.25 %, fiber 1.33 and 5.64 % and moisture 5.36 and 3.78 %, respectively. Codina-Torrella *et al.* (2014) reported that, the tiger-nut contain from 25.35 to 28.19% fat and 3.28 to 7.32% protein. The predominant constituent in JR carbohydrates was being was 78.00 % and follows by protein as being 9.8%. However, the carbohydrate and follows by crude fat, 41.22 and 35.43, respectively, were the most predominate nutrients constituent in TN .

~~crude fat, 41.22 and 35.43, respectively, were the most predominate nutrients constituent in TN (Table 1). Soaking process improved chemical composition of TN as presented in table 2.~~

Table (1):1. Chemical comparison of *Jerusalem artichoke* (JAJR) and *Tigernut* (TN) /100 g dry base

Nutrients	RDV*	JAJR		TN	
		Contents **	% of RDV	Contents **	% of RDV
Protein (g)	50	9.8±0.36	19.6	9.7±0.16	19.40

Fat (g)	65	0.38±0.22	0.58	35.43±0.35	54.51
Ash (g)	-	5.22±0.18	-	4.25±0.44	-
Fiber (g)	25	1.33±0.67	5.32	5.64±0.15	22.56
Moisture (g)	-	5.36±0.12	-	3.78±0.65	-
Carbohydrate (g)	300	78.00±0.31	26.00	41.22±0.35	13.74

*** RDV : Relative daily value; from the Food and Nutrition Board (2002);**

**** Values represent the mean ±SD of triplicate measurements**

Amino acids content in ~~JA~~ JR and TN:

Amino acids (AA) content in JR and TN are presented in Table (2). Results revealed that, the protein content of JR and TN containing total essential AA 19.89 and 14.33 g/100g protein, respectively, including methionine +cysteine, isoleucine, phenylalanine, threonine, valine and lysine with slightly differences between JR and TN. ~~It found~~ Data showed that, phenylalanine + tyrosine content was higher in JR than in TN. However, the overall quality of protein in the JR compromised by its high phenylalanine+ tyrosine content 6.13 % of the total essential AA. Tryptophan was the least concentrated, in JR with values of 0.82 g/100g protein. ~~However, JR contained the second predominant AA of lysine; leucine follows by valine as 2.9616, and similar ratio of leucine and valine 2.34 g/100g from total essential AA. In Table 32, TN was contained an abundant AA ratio of lysine (2.47g/100g), follows by leucine (2.37 g/100g) and valine (2.16 g/100g). These results are lowering than obtained by Temple *et al.* (1989) who reported that chufa contain lysine (4.9 g/ g/100g protein), leucine (2.9 g/100g protein) and valine (2.5 g/100 g protein). It is interesting to note that, the phenylalanine + tyrosine content of the JR was provide 97.3% of the WHO ideal protein standard. Proportion of tryptophan and follows by threonine and valine in JR provide 74.5 and about of 66.0 % for the ideal standard protein of WHO. Total essential AA in TN (14.33 g/100g protein) which in lower than in JR (19.89g/100g protein). TN amino acid pattern provide about 11.3% of tryptophan was higher than WHO standard protein for children (Table 2). Compared to standard percentage amino acid in WHO profile , both of JR and TN were lacked in leucine and aromatic amino acids (phenylalanine+ tyrosine) , respectively.~~

~~Concerning non-essential AA content of JR and TN the results revealed that, the major abundant non-essential AA in JR were arginine acid, glutamic acid, proline and aspartic with values 21.17, 18.61, 12.96 and 11.68 g/100g protein, respectively. TN contain high amount of arginine, which liberates insulin hormone and provides some digestive enzymes like catalase, lipase, and amylase, it could recommended for those who have problems with digestion, flatulence and diarrhea, also TN milk is a suitable drink for celiac patients and for the lactose-intolerant (Adejuyitan, 2011). Total non-essential AA for JA and TN accounted 80.11 and 85.67 g/100g protein, respectively. The Predicted Protein Efficiency Ratio (P-PER) is one of the quality parameters used for protein evaluation (FAO/WHO, 1991). The P-~~

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Normal, Justify Low

Formatted: Font: (Default) Arial, 9 pt, Not Bold, Complex Script Font: Arial, 9 pt, Not Bold

Formatted: Justify Low

Formatted: Font: (Default) Arial, 9 pt, Complex Script Font: Arial, 9 pt

Formatted: Font: (Default) Arial, 9 pt, Not Bold, Complex Script Font: Arial, 9 pt, Not Bold

Formatted: Justify Low

Formatted: Font: (Default) Arial, 9 pt, Complex Script Font: Arial, 9 pt

...rmatted

Formatted: Justify Low

...rmatted

...rmatted

Formatted: Justify Low

...rmatted

...rmatted [1]: Comment [h: فضلا اضافة SD

...rmatted

...rmatted

...rmatted

Formatted: Justify Low

...rmatted

...rmatted

Formatted: Justify Low

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

~~PER of JA JR and TN was 0.55 and 0.5552, respectively. This study showed that JA JR and TN nutritionally useful quantities of most of the essential amino acids and can serve as food supplements.~~

Table ~~(2)~~2. Amino acids (AA) content (g/100g protein) of ~~JA~~ JR and TN

AA composition	WHO* ideal AA(g/100) protein)	JR		TN	
		AA	% WHO	AA	% WHO
Essential AA					
Isoleucine	2.8	1.84	65.7	1.24	44.29
Leucine	6.6	2.34	35.5	2.37	35.91
Lysine	5.8	2.96	51.0	2.47	42.59
Methionine+Cysetine	2.5	1.22	48.8	1.13	45.20
Phenylalanine+Tyrosine	6.3	6.13	97.3	1.86	29.52
Phenylalnine	-	2.13	-	0.99	-
Tyrosine	-	4.00	-	0.87	-
Threonine	3.4	2.24	65.9	1.86	54.71
Tryptophan	1.1	0.82	74.5	1.24	112.73
Valine	3.5	2.34	66.9	2.16	61.71
Total essential AA	32.0	19.89	62.16	14.33	44.78
Non-essential AA					
Aspartic		11.68		13.12	
Glutamic		18.61		17.50	
Serine		3.47		5.83	
Proline		12.96		5.47	
Glycine		4.01		6.93	
Alanine		5.11		8.02	
Histidine		3.10		2.92	
Arginine		21.17		25.88	
Total non-essential AA		80.11		85.67	
P-PER		0.55		0.52	

P-PER: Predicted protein efficiency ratio.
***WHO (1985) WHO/FAO Report.**

However, JR contained the second predominant AA of lysine; leucine follows by valine as 2.16, and similar ratio of leucine and valine 2.34 g/100g from total essential AA. In Table 2, TN contained an abundant AA ratio of lysine (2.47g/100g), follows by leucine (2.37 g/100g) and valine (2.16 g/100g). These results are lowering than obtained by Temple *et al.* (1989) who reported that chufa contain lysine (4.9 g/ g/100g protein), leucine (2.9 g/100g protein) and valine (2.5 g/100 g protein). It is interesting to note that, the phenylalanine + tyrosine content of the JR was provide 97.3% of the WHO ideal protein standard. Proportion of tryptophan and follows by threonine and valine in JR provide 74.5 and about of 66.0 % for the ideal standard protein of WHO. Total essential AA in TN (14.33 g/100g protein) which in lower than in JR (19.89g/100g protein). TN amino acid pattern provide about 11.3% of tryptophan was higher than WHO standard protein for

children (Table 2). Compared to standard percentage amino acid in WHO profile , both of JR and TN were lacked in leucine and aromatic amino acids (phenylalanine+ tyrosine) , respectively.

Concerning non-essential AA content of JR and TN the results revealed that, the major abundant non-essential AA in JR were arginine acid, glutamic acid, proline and aspartic with values 21.17, 18.61, 12.96 and 11.68 g/100g protein, respectively. TN contain high amount of arginine, which liberates insulin hormone and provides some digestive enzymes like catalase, lipase, and amylase, it could recommended for those who have problems with digestion, flatulence and diarrhea, also TN milk is a suitable drink for celiac patients and for the lactose-intolerant (Adejuyitan, 2011). Total non-essential AA for JA and TN accounted

80.11 and 85.67 g/100g protein, respectively. The Predicted Protein Efficiency Ratio (P-PER) is one of the quality parameters used for protein evaluation (FAO/WHO, 1991). The P-PER of JR and TN was 0.55 and 0.52, respectively. This study showed that JR and TN nutritionally useful quantities of most of the essential amino acids and can serve as food supplements.

Fatty acids ~~contents~~ composition in ~~JA~~ JR and TN:

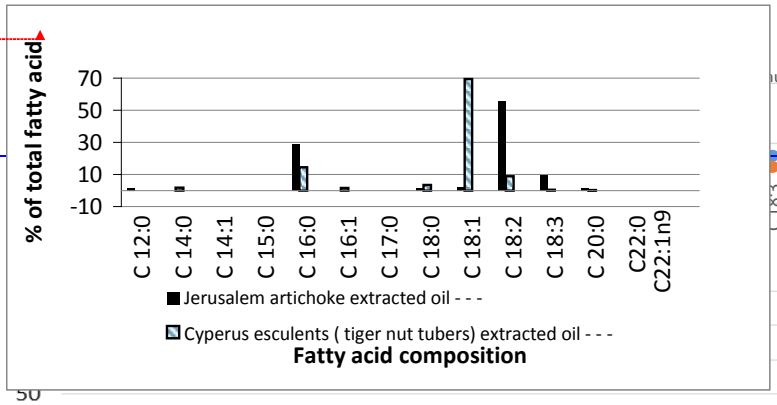
~~Figure (1~~Fig 1.~~)~~ illustrated fatty acids composition ~~content~~ of crude lipid fraction from ~~JA~~ JR and TN. The results revealed that, JR fatty acid profile is predominant in linoleic acid, c18:2n6 (55.34 %) and follows by palmitic acid, C16:0 (29.04%) and linolenic acid, C18:3n3 (9.6%), these account more than 94% of total fatty acid. Oleic acid is the major fatty acid in TN ratio about 70% follows by palmitic acid, C16:0 and Linoleic acid, c18:2n6 (14.5 % and 8.8%, respectively). Similar result by Muhammad *et al*. (2011) who found that, TN oil is predominantly consists of oleic acid with values ranging from 65.5 to 76.1%. Dubois *et al*. (2007) reported that , the major fatty acids in TN oil are 14:0 (0.2%), 18:0 (3.2%), 20:0 (0.4%), 16:1 n −7 (0.3%), 18:1 n−9 (72.6%), 18:2 n−6 (8.9%), and 18:3 n−3 (0.4%). Moreover, TN oil has a monounsaturated profile (>60% monounsaturated fatty acids (MUFA)), similar to fatty acid profile of olive oil, hazelnut, macadamia nut, avocado, and apricot kernel oils (Dubois *et al*., 2007). Tigernuts reported as a helping agent in prevention heart attack and thrombosis by enhancing blood circulation, reducing low density lipoprotein (LDL-C) and increasing high density lipoprotein (HDL-C) (Belewu and Abodunrin, 2006). Daily consumption of TN has been shown to be effective in weight loss and improvement the metabolic disorders among obese diabetic patients (Salwa *et al*., 2010).

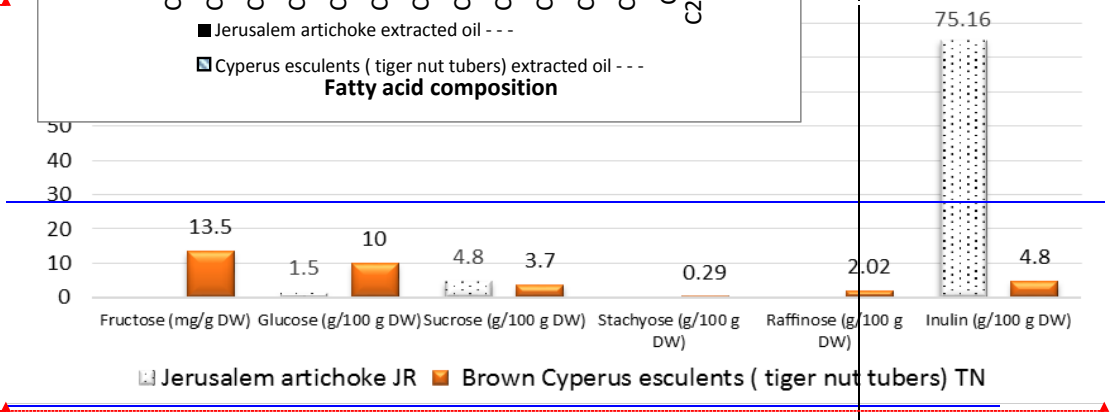
Polysaccharides content of JR and TN:

As shown in Figure (2) the polysaccharide content in JR and TN were defiantly different between each of them. Inulin was the most abundant in JR (75.16 g), follows by sucrose (4.8 g) and glucose (1.5 g). This result is also obtained by Franck (2000) who indicated that, JR is contains 95% inulin on dry matter. Fructose was the most abundant sugar in TN (13.5 g), follow by glucose and inulin (10.0 and 4.8 g, respectively), therefore, TN is suitable for diabetes. Inulin and fructose considered as bioactive ingredients, which might

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Normal, Justify Low
Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Justify Low
Formatted: Justify Low, Indent: First line: 0.95 cm
Formatted: Justify Low
Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted

be surprise as relevant to modify and improve the technical production of fermented milk and yoghurts. Inulin at ratio 2-4% is increase the firmness of fermented milk by *Streptococcus* and inoculated with *Bifidobacterium lactis* (Pinheiro *et al*. 2009). Gibson *et al*. (2004) reported that, the polysaccharide inulin is a soluble dietary fiber, which is not degraded by enzymes in the human digestive system, but fermented selectively by beneficial bacteria in the gut. Inulin and its degradation products are capable of stimulating and/or activating health-promoting bacterial growth in the colon. Moreover, inulin increases blood glucose level less than starch, and it is therefore suited as a constituent in an anti-diabetic diet (Rumessen *et al*., 1990).





Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted: Left-to-right
Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Justify Low
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Left
Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold
Formatted: Left-to-right
Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold

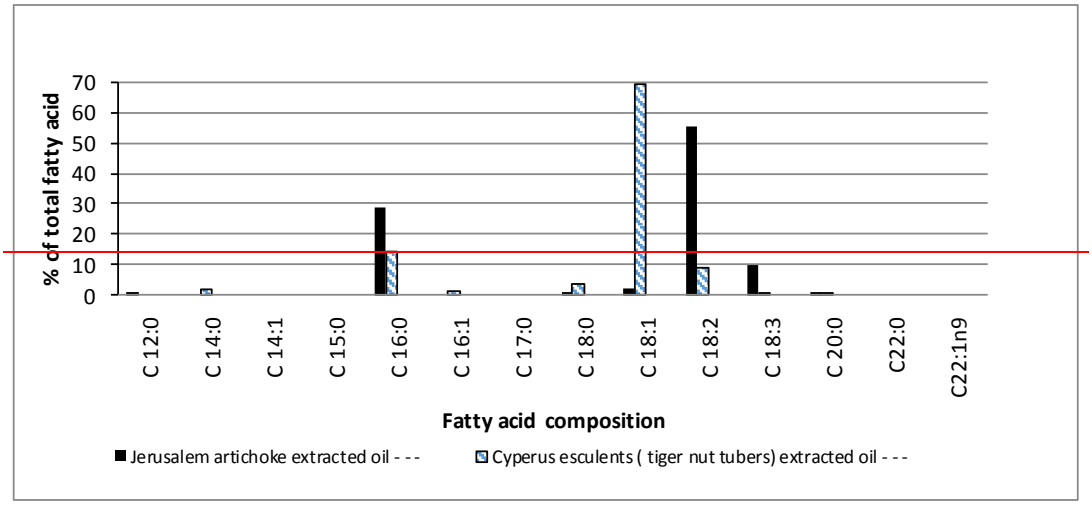
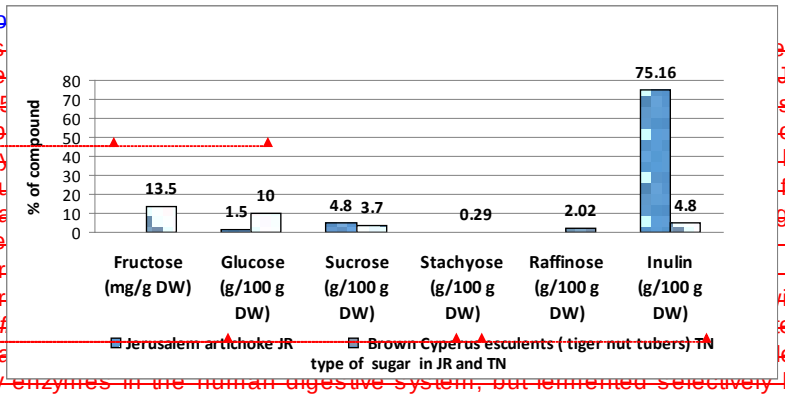


Figure (21):Fig 1. Fatty acids content composition of JA JR and TN



Po

As ere
de JR
(75 so
ob on
dr by
gl for
di ght
be of
fer of
fer ith
Bif ed
tha led
by enzymes in the human digestive system, but fermented selectively by beneficial bacteria in the gut. Inulin and its degradation products are capable of stimulating and/or activating health-promoting bacterial growth in the colon. Moreover, inulin increases blood glucose level less than starch, and it is therefore suited as a constituent in an anti-diabetic diet (Rumessen *et al.*, 1990).

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Normal, Justify Low
Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Font: Arial, 10 pt, Complex Script Font: 10 pt
Formatted: Font: Arial, 10 pt, Complex Script Font: 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Justify Low, Line spacing: single
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Justify Low, Indent: First line: 0 cm, Line spacing: single
Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Not Bold, Complex Script Font: Arial, 10 pt, Not Bold
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
... [1] Formatted
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
... [2] Formatted
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
... [3] Formatted

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic

Formatted: Left-to-right

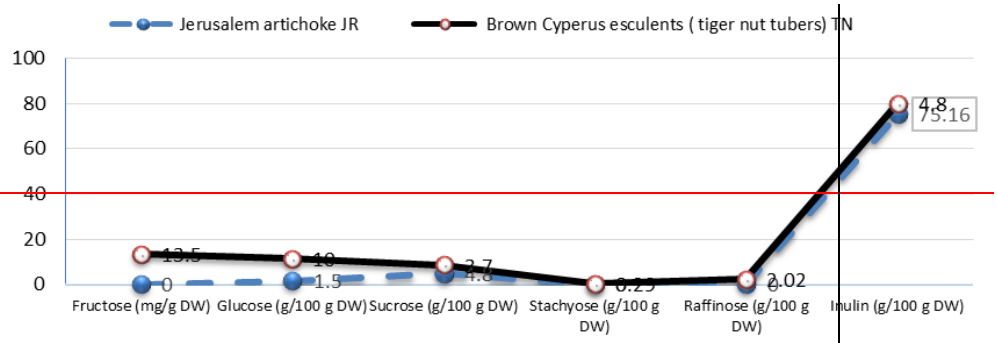
Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

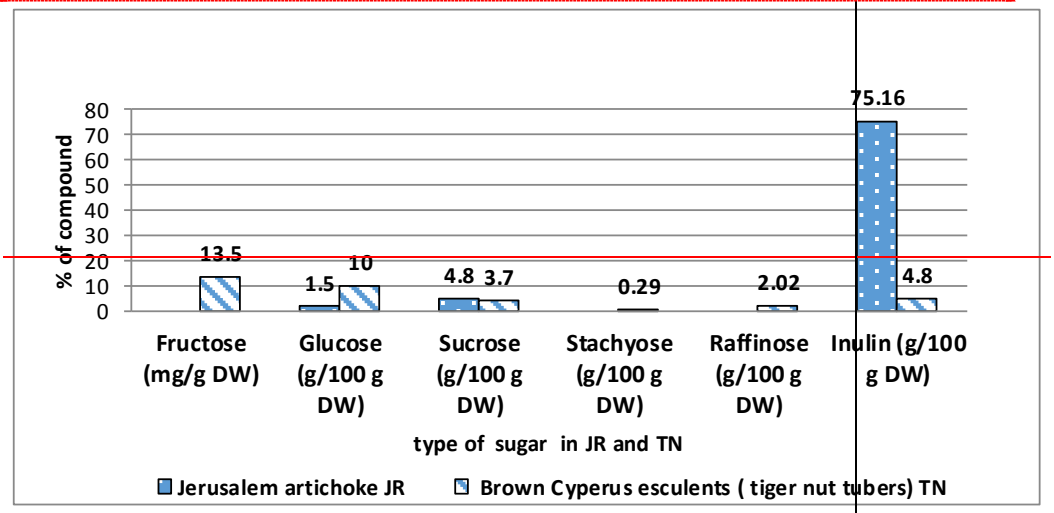
Formatted: Font: (Default) Arial, 1 pt, Complex Script Font: Arial, 1 pt

Formatted: Justify Low

Formatted: Font: (Default) Arial, 1 pt, Complex Script Font: Arial, 1 pt



Formatted: Font: Arial, 10 pt, Complex Script Font: 10 pt



Formatted: Font: Arial, 10 pt, Complex Script Font: 10 pt

Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold

Formatted: Left-to-right

Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold

Figure (2):Fig 2. Polysaccharides content in Jerusalem artichoke and tiger nut tubers

Vitamins content in JA JR and TN:

The mostabundant vitamin compound in JA JR and TN were vit E and vit B1 and B2, these vitamins were the main task in human nutrition and antioxidant role in biological systems (Table 3). In terms of their nutrient content, the TN seeds compare richen in vitamin compare with those of JR; except for Vit B2, both plants seem capable of satisfying less than 6% of an adult's requirement for the various nutrients listed in Table (3). The TN provided an adequate quantity of Vitamins E and B1 about 54 and 21%, respectively versus than RDV recommendation. A quite similar vitamin content in JR when compared to TN, vitamin E and Vit B1 accounted 47.33 and 13.27 as % of RDV, respectively. The obtained results were agree with Belewu *et al.* (2007).

with those of JA; except for Vit B2, both plants seem capable of satisfying less than 6% of an adult's requirement for the various nutrients listed in Table (3). The TN provided an adequate quantity of Vitamins E and B1 about 54 and 21%, respectively versus than RDV recommendation. A quite similar vitamin content in JA when compared to TN, vitamin E and Vit B1 accounted 47.33 and 13.27 as % of RDV, respectively. The obtained results were agree with Belewu et al. (2007).

Table (3):3. Vitamins content in JA and TN (100 g dry base)

Vitamins	RDV*	JA JR		TN	
		Contents**	% of RDV	Contents **	% of RDV
Vit B1 (mg)	1.50	0.199 ±0.48	13.27	0.31±0.35	20.67
Vit B2 (mg)	1.70	0.089±0.16	5.24	0.10±0.63	5.88
Vit E (mg)	15	7.1±0.19	47.33	8.0±0.13	53.33
Vit C (mg)	90	1.5±0.62	1.67	5.4±0.02	6.00

***Relative daily value (RDV); from the Food and Nutrition Board (2002).**
**** Values represent the mean ±SD of triplicate measurements**

~~with those of JR; except for Vit B2, both plants seem capable of satisfying less than 6% of an adult's requirement for the various nutrients listed in Table (3). The TN provided an adequate quantity of Vitamins E and B1 about 54 and 21%, respectively versus than RDV recommendation. A quite similar vitamin content in JR when compared to TN, vitamin E and Vit B1 accounted 47.33 and 13.27 as % of RDV, respectively. The obtained results were agree with Belewu *et al.* (2007).~~

Minerals content in JA JR and TN:

Minerals content in JA JR and TN illustrated in (Table 4), JA JR contained a relatively large amount of micronutrient and macro nutrient elements than in TN such as Zn, Mo, P and Cu accounting (17.17, 11.92, 370 and 5.35 mg/kg dry weight, respectively). However, TN was containing a considerable amount of sulfur, Mn, Ca, Mg and Fe (1369, 11.39, 150, 132.3 and 131.5 mg/kg on dry base, respectively). These minerals are important for human. 100 g of JA JR provide a sufficient amount more than quarter ratio of copper USDA recommend. Both of JA JR and TN are good sources of Fe, Zn, and Mg, while TN is only contain a higher ratio of Cu. These elements are very important in human malnutrition and diabetic diseases (Edem *et al.*,

2009). Iron is necessary for the prevention of anemia, and zinc necessary for nucleic acid metabolism، protein synthesis and cell growth (Igoe, 1989). Molybdenum is an essential element in human nutrition, its enhanced stress response in human body which exposure to xenobiotic compounds and involves detoxification of these compounds (Luo *et al.* 1983).

Table (4):4. Mineral contents of JA JR and TN.

	Minerals mg/kg								
	Ca	P	Mg	Mo	Fe	Zn	Cu	Mn	S
JA JR mg/kg	120	370	1127	11.92	117.2	17.17	5.35	10.84	1250
TN mg/kg	150	330	1323	9.75	131.5	12.11	ND	11.39	1369
RDV* (mg)	1000 mg	1000 mg	400 mg	75 mg	18 mg	15 mg	2.0 mg	2.0 mg	-

*Relative daily value (RDV); from the Food and Nutrition Board (2002)

~~element in human nutrition, its enhanced stress response in human body which exposure to xenobiotic compounds and involves detoxification of these compounds (Luo *et al.* 1983).~~

GC-MS analysis in JA JR and TN:

Data from the analysis of JA JR and TN volatile components are illustrated in Table (5). It showed that, 20 compounds in JAJR, and 18 compounds in TN were tentatively identified. Most of these methanolic extract from two plants are bosses as bioactive compounds and antimicrobial agents. The largest portion of GC-MS profile of JA JR was propionic acid, nonal ester (29.605%), followed by D-allothreonine (11.84%) and Acetic acid, ethoxyhydroxy-, ethyl ester (10.526%). D-allothreonine is one of essential amino acid, which maintains phospholipid metabolism and physiology in liver cells (Kathayat *et al.*, 1997). The largest portion of GC-MS profile in TN was l-(+)-Ascorbic acid 2,6-dihexadecanoate (40.773%), followed by 2-Butenedioic acid (E)-, bis(2-ethylhexyl ester (13.305%) and palmitic acid (10.730%) of total identified GC MS compound. Moreover, TN contains hydrocarbon compounds such as B-Cymene, D-Limonene and Psi-limonene in ranged between 1.5-2.57% from total GC-Ms profile. This result is agree with Kubmarawa *et al.* (2005) who reported that, TN contained high amounts were ρ-cymene (1.3–2.8%), limonene (1.3–2.8%), myrcene (1.7–1.8 %) and sabinene (1.0–6.9 %). B-Cymene, which has a biological role in

antimicrobial activity, as well as two aromatic alcohols of O-thymol and menthol were identified in TN.

Huisman *et al.* (2004) reported that, JR contained many important alcoholic compounds such (-)-isopulegol, 2-p-cymenol, thymol acetate and geranyl isovalerate, these alcoholic material exhibited antioxidant properties. Caryophyllene compound such as γ-Gurjunene has been identified in JR at ratio 3.947% of total identified GC-MS compounds. Several biological activities attributed to *β*-caryophyllene, such as anti-inflammatory, antibiotic, antioxidant, anticarcinogenic and local anaesthetic activities. This result agree with Legault and Pichette (2007). In addition, caryophyllene oxide recognized as stabilizer in foodstuff, drugs and cosmetics and has shown growth inhibiting activity against dermatophytes (Yang *et al*., 1999). It has also shown growth inhibitory effects on *Staphylococcus aureus* (Katsuyama *et al*., 2005). Thymol (phenolic monoterpenes) was identified in both plant of JR and TN. It has relatively strong antimicrobial activities (Burt 2004). It was synergistically active against *E. coli* strains acting by thymol disintegrated the outer membrane of *E. coli* (Lambert *et al.* 2001).

Fatty acid (FA) composition of bio-yoghourt:

Table (6) represents the overall FA composition in bio-yoghourt fortified with JR or TN flour, 17 FA detected, comprised of both saturated and unsaturated FA. Long chain FA profile of control bio-yoghourt shows Palmitic (C16:0), oleic acid (C18:1), myristic (C16:0) and stearic acids (C18:0) being relatively high. Relative proportion of different FA is underwent changes during processing. Fortified bio-yoghurt with JR induced changes than control yoghurt, where it decreased oleic acid (8.44), increased low molecular FA as caproic (C6:0) and caprileic acid, (C8:0), as well as increased linoleic acid (C18:2n6) up to 18.17%, which is 6 times more than the amount in the control sample.

~~followed by 2-Butenedioic acid (E)-, bis(2-ethylhexyl ester (13.305%) and palmitic acid (10.730%) of total identified GC-MS compound. Moreover, TN contains hydrocarbon compounds such as B-Cymene, D-Limonene and Psi-limonene in ranged between 1.5-2.57% from total GC-Ms profile. This result is agree with Kubmarawa *et al.* (2005) who reported that, TN contained high amounts were p-cymene (1.3–2.8%), limonene (1.3–2.8%), myrcene (1.7–1.8 %) and sabinene (1.0–6.9 %). B-Cymene, which has a biological role in antimicrobial activity, as well as two aromatic alcohols of O-thymol and menthol were identified in TN.~~

~~Huisman *et al.* (2004) reported that, JA contain many important alcoholic compounds such (-)-isopulegol, 2-p-cymenol, thymol acetate and geranyl isovalerate, these alcoholic material exhibited antioxidant properties. Caryophyllene compound such as γ-Gurjunene has been identified in JA at ratio 3.947% of total identified GC-MS compounds. Several biological activities attributed to *β*-caryophyllene, such as anti-inflammatory, antibiotic, antioxidant, anticarcinogenic and local anaesthetic activities. This result~~

agree with Legault and Pichette (2007). In addition, caryophyllene oxide recognized as stabilizer in foodstuff, drugs and cosmetics and has shown growth inhibiting activity against dermatophytes (Yang *et al*., 1999). It has also shown growth inhibitory effects on *Staphylococcus aureus* (Katsuyama *et al*., 2005). Thymol (phenolic monoterpenes) was identified in both plant of JA and TN. It has relatively strong antimicrobial activities (Burt, 2004). It was synergistically active against *E. coli* strains acting by thymol disintegrated the outer membrane of *E. coli* (Lambert *et al*., 2001).

Fatty acid (FA) composition of bio-yoghourt:

Table (6) represents the overall FA composition in bio-yoghourt fortified with JA or TN flour, 17 FA detected, comprised of both saturated and unsaturated FA. Long chain FA profile of control bio-yoghourt shows Palmitic (C16:0), oleic acid (C18:1), myristic (C16:0) and stearic acids (C18:0) being relatively high. Relative proportion of different FA is underwent changes during processing. Fortified bio-yoghurt with JA induced changed than control yoghurt, where it decreased oleic acid (8.44), increased low molecular FA as caproic (C6:0) and caprileic acid, (C8:0), as well as increased linoleic acid (C18:2n6) up to 18.17%, which is 6 times more than the amount in the control sample. Linoleic acids (CLA) has attributed as anticarcinogenic properties, as well as antiatherogenic effects, and also known as rumenic acid (Masso-Welch *et al*., 2004). Fortified bio-yoghurt with TN showed higher oleic acid and lower C18:2n6 than found in JA bio-yoghurt. Fortified bio-yoghurt with TN increased oleic acid from 22.35% in control to 35.70%, as well as increased CLA up to 7.10%, while decreased Stearic acid than control bio-yoghurt. Low molecular FA is lower in TN bio-yoghurt than in control and JA bio-yoghurt. These FA are responsible to improve aroma of processed yoghurt. It seems that individual fatty acids followed different pattern of changes during processing or fermentation. Therefore, it assumed that, fortification bio-yoghurt contains probiotic bacteria with JA or TN induce improve growth of probiotic bacteria and produce important CLA, which has anticancer and anti hypercholestrolemic activities.

Table ~~(5):~~5. GC-MS components of ~~JA~~ JR and TN methanol extract.

RT	Compound name in ~~JA~~ JR	Peak area %	Compound name in TN	Peak area %
3.22	Propionic acid , nonal ester	29.605		
3.23			2-Butenedioic acid (E)-, bis(2-ethylhexyl ester	13.305
3.31	Butanoic acid , 2,4-diamino	4.934		
3.71	Acetic acid, ethoxyhydroxy-, ethyl ester	10.526		
3.81	D-allothreonine	11.842		
4.75			O-thymol	1.073
6.36			Acetic acid, 2,2-{oxybis(2,1-ethyl)ester	1.073
6.81	Phenol, 4-(2-aminopropyl)	2.303		
7.04			B-Cymene	2.146
7.09			D-Limonene	2.575
8.15	(-)- ISOPULEGOl	2.303		
8.16			Psi-limonene	1.502
9.31			Menthol, (±)-	2.146
9.41			Cis-B-Terpinenol	0.858
9.67			Benzoic acid, 2-hydroxy-, hydrazide	3.863
10.70	Methoxyacetic acid , 2-pentadecyl ester	1.645		
10.22	2-P-CYMENOL	2.303		
10.92			Anethole	0.773
11.1			Carvacryl acetate	6.438
11.12			5-Isopropenyl-2-methyl-2-cyclohexen-1-one	5.579
11.3	Thymol acetate	2.467		
12.25	Geranyl isovalerate	1.974		
12.92	Methoxyacetic acid, 3-tetradecyl ester	1.974		
13.47	Eicosane,10-Methyl	1.974		
13.73	γ-Gurjunene	3.947		
13.99			Geranyl isovalerate	0.773
14.73			Butyric acid, 4-pentadecyl ester	1.073
14.74	Butyric acid, 4-pentadecyl ester	4.934		
15.9	TETRADECANE, 2,6,10-TRIMETHYL	1.974		
16.36	TRICOSANE	3.947		
16.47			Stearic acid	1.717
18.13	OCTADECANE	3.618		
18.13			Hexadecanoic acid, methyl ester	3.433
18.6	Nonahexacontanoic acid	2.303		
18.71	Phthalic acid, isobutyl octadecyl ester	2.632		
18.74			l-(+)-Ascorbic acid 2,6-dihexadecanoate	40.773
18.92	Hexadecanoic acid, methyl ester	2.632		
18.93			Palmitic acid	10.730

and caprileic acid, (C8:0), as well as increased linoleic acid (C18:2n6) up to 18.17%, which is 6 times more than the amount in the control sample. Linoleic acids (CLA) has attributed as followed by 2-Butenedioic acid (E)-, bis(2-ethylhexyl) ester (13.305%) and palmitic acid (10.730%) of total identified GC MS compound. Moreover, TN contains hydrocarbon compounds such as B-Cymene, D-Limonene and Psi-limonene in ranged between 1.5-2.57% from total GC-Ms profile. This result is agree with Kubmarawa *et al.* (2005) who reported that, TN contained high amounts were p-cymene (1.3–2.8%), limonene (1.3–2.8%), myrcene (1.7–1.8 %) and sabinene (1.0–6.9 %). B-Cymene, which has a biological role in antimicrobial activity, as well as two aromatic alcohols of O-thymol and menthol were identified in TN.

Huisman *et al.* (2004) reported that, JR contained many important alcoholic compounds such (-)-isopulegol, 2-p-cymenol, thymol acetate and geranyl isovalerate, these alcoholic material exhibited antioxidant properties. Caryophyllene compound such as γ-Gurjunene has been identified in JR at ratio 3.947% of total identified GC-MS compounds. Several biological activities attributed to *β*-caryophyllene, such as anti-inflammatory, antibiotic, antioxidant, anticarcinogenic and local anaesthetic activities. This result agree with Legault and Pichette (2007). In addition, caryophyllene oxide recognized as stabilizer in foodstuff, drugs and cosmetics and has shown growth inhibiting activity against dermatophytes (Yang *et al.*, 1999). It has also shown growth inhibitory effects on *Staphylococcus aureus* (Katsuyama *et al.*, 2005). Thymol (phenolic monoterpenes) was identified in both plant of JR and TN. It has relatively strong antimicrobial activities (Burt, 2004). It was synergistically active against *E. coli* strains acting by thymol disintegrated the outer membrane of *E. coli* (Lambert *et al.*, 2001).

Fatty acid (FA) composition of bio-yoghourt:

Table (6) represents the overall FA composition in bio-yoghourt fortified with JR or TN flour. 17 FA detected, comprised of both saturated and unsaturated FA. Long chain FA profile of control bio-yoghourt shows Palmitic (C16:0), oleic acid (C18:1), myristic (C16:0) and stearic acids (C18:0) being relatively high. Relative proportion of different FA is underwent changes during processing. Fortified bio-yoghourt with JR induced changes than control yoghurt, where it decreased oleic acid (8.44), increased low molecular FA as caproic (C6:0) and caprileic acid, (C8:0), as well as increased linoleic acid (C18:2n6) up to 18.17%, which is 6 times more than the amount in the control sample. Linoleic acids (CLA) has attributed as anticarcinogenic properties, as well as antiatherogenic effects, and also known as rumenic acid (Masso-Welch *et al.*, 2004). Fortified bio-yoghourt with TN showed higher oleic acid and lower C18:2n6 than found in JR bio-yoghourt. Fortified bio-yoghourt with TN increased oleic acid from 22.35% in control to 35.70%, as well as increased CLA up to 7.10%, while decreased Stearic acid than control bio-yoghourt. Low molecular FA is lower in TN bio-yoghourt than in control and JR bio-yoghourt. These FA are responsible to improve aroma of processed yoghourt. It seems that individual fatty acids followed different pattern of changes during processing or fermentation. Therefore, it assumed that, fortification bio-

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted
Formatted: Left-to-right
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Justify Low, Indent: First line: 0 cm, Line spacing: single
Formatted
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted
Formatted: Justify Low, Line spacing: single
Formatted: Justify Low
Formatted
Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold
Formatted: Left-to-right
Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold

yoghurt containing probiotic bacteria with JR or TN led to improve growth of probiotic bacteria and produce important CLA, which has anticancer and anti hypercholestrolemic activities. acid from 22.35% in control to 35.70%, as well as increased CLA up to 7.10%, while decreased Stearic acid than control bio-yoghurt. Low molecular FA is lower in TN bio-yoghurt than in control and JR bio-yoghurt. These FA are responsible to improve aroma of processed yoghurt. It seems that individual fatty acids followed different pattern of changes during processing or fermentation. Therefore, it assumed that, fortification bio-yoghurt containing probiotic bacteria with JR or TN led to improve growth of probiotic bacteria and produce important CLA, which has anticancer and anti hypercholestrolemic activities.

Table (6):6. Fatty acid composition of bio-yoghourt fortified with JA JR or TN flour.

Fatty acids	Control	Fortified with JAJR	Fortified with TN
Caproic Acid, C6:0	2.02	3.29	2.25
Caprilic Acid, C8:0	1.19	2.28	0.25
Capric Acid, C10:0	4.28	3.19	2.48
Lauric Acid, C12:0	4.16	3.22	1.17
Myristic Acid, C14:0	12.38	10.24	9.28
Myristoleic Acid, C14:1	1.16	2.25	2.28
Pentadecanoic Acid, C15:0	2.18	0.99	0.72
Palmitic Acid, C16:0	27.87	25.23	28.59
Palmitoleic Acid, C16:1	1.95	0.50	0.33
Heptadecanoic Acid, C17:0 C17:0	1.41	0.23	0.28
Stearic Acid, C18:0	10.28	12.15	6.24
Oleic Acid, C18:1n9c	22.35	8.44	35.70
Linoleic Acid, C18:2n6	3.62	18.17	7.12
Linolenic Acid, C18:3n3	3.84	8.69	2.78
Arachidic Acid, C20:0	0.22	0.59	0.23
Behenic Acid, C22:0	0.87	0.54	0.16
Eurcic Acid C22:1n9	0.22	-	0.14

acid from 22.35% in control to 35.70%, as well as increased CLA up to 7.10%, while decreased Stearic acid than control bio-yoghurt. Low molecular FA is lower in TN bio-yoghurt than in control and JR bio-yoghurt. These FA are responsible to improve aroma of processed yoghurt. It seems that individual fatty acids followed different pattern of changes during processing or fermentation. Therefore, it assumed that, fortification bio-yoghurt containing probiotic bacteria with JR or TN led to improve growth of probiotic bacteria and produce important CLA, which has anticancer and anti hypercholestrolemic activities.

Texture profile of bio-yoghurt fortified with ~~JA~~ JR and TN:

The instrumental texture profile of bio- yoghurt fortified with 10% of ~~JA~~ JR or TN have shown in Table (7). There was an increase in all texture parameters analyzed. Firmness of fortified bio-yoghurt was increased from 5.55 for control to 8.21and 9.22 for ~~JA~~ JR and TN, respectively. There is no variation between fortified bio-yoghurt with JA or TN, whereas, there were increase in cohesiveness compare to control bio-yoghurt. Gumminess, chewiness and springiness of different bio-yoghurts 2.16, 1.08 and 0.33 to 2.22, 1.29 and 0.48, respectively showed differences between ~~JA~~ JR and TN bio-yoghurt. The stability of texture profile ~~is~~ was desirable to maintain physical-chemical and sensory properties after fermentation and storage period. The increase in firmness may be related to dietary fiber absorbing more moisture because of its higher water-holding capacity (Hashim *et al*.~~,~~ 2009), and oil-holding capacity, emulsification and/or gel formation. (Elleuch *et al*.~~,~~ 2011). It has been suggested that inulin is a water-structuring agent and it may form a complex with protein aggregates in yoghurt, which could explain the increase in firmness in these products (Kip *et al*., 2006). Similar to Srisuvor *et al*. (2013) and Oliveira *et al*. (2011) inulin addition to co-cultures and cocktail enhanced products firmness, either after 1 day or 7 days of cold storage, likely due to the increase in microbial growth induced by metabolic interactions among lactic acid bacteria and partial inulin metabolization. Moreover, Tamime (2005) found that the higher microbial growth is one of the causes of a firmness increase in yoghurt.

~~Similar to Srisuvor *et al*. (2013) and De Souza Oliveira *et al*. (2011) inulin addition to co-cultures and cocktail enhanced products firmness, either after 1 day or 7 days of cold storage, likely due to the increase in microbial growth induced by metabolic interactions among lactic acid bacteria and partial inulin metabolization. Moreover, Tamime (2005) found that the higher microbial growth is one of the causes of a firmness increase in yoghurt.~~

Table ~~(7):~~7. Texture profile analysis of bio-yoghurt fortified with ~~JA~~ JR or TN (10%) flour

Texture profile	Control	Fortified with ~~JA~~JR	Fortified with TN
Firmness (N)	5.55±0.29	8.21±1.35	9.22±0.99
Cohesiveness	0.25 ±0.22	0.78±0.11	0.79±0.18
Gumminess (g)	1.28±0.13	2.16±1.47	2.22±1.14
Chewiness (g×mm)	0.39±0.04	1.08±1.31	1.29±0.90
Springiness (mm)	0.24±0.12	0.33±0.09	0.48±0.78

Table ~~(8):~~8. Organoleptic evaluation for bio yogurts fortified with 10% JR or TN

Taste parameter	Control	Fortified with *biofedobacterium* and JR	Fortified with *biofedobacterium* and TN

Sourness	6.3± 1.9	6.5± 2.2	5.3± 1.2
Bitterness	4.2± 1.2	3.1± 0.7	2.2± 1.6
Sweetness	2.6± 1.6	4.3± 1.5	5.7± 1.0
Aroma	6.3± 0.8	4.2± 1.7	5.8± 2.1
Overall acceptability	6.7± 0.2	5.3± 1.8	7.1± 1.7

due to the increase in microbial growth induced by metabolic interactions among lactic acid bacteria and partial inulin metabolization. Moreover, Tamime (2005) found that the higher microbial growth is one of the causes of a firmness increase in yoghurt.

Organoleptic evaluation for bio- yogurts:

Results from Table (8) showed organoleptic evaluation of bio-yoghurt fortified with 10% of JA JR or TN. Sourness was decrease in fortified TN. The TN bio-yoghourt was lower in brightness than control and JA JR bio-yoghurt. Characteristics of color of fortified TN were naturally brown, which affect the overall color and brightness. Increasing of sweetness in TN bio-yoghurts attributes to the level of sweeteners of fructose and glucose content in TN compared to control and JA JR yoghurts. Bio-yoghurt fortified with JA JR has impassive in aroma than control and TN yoghurt. There was a defiantly higher overall acceptability in TN than control and JA JR bio-yoghurt. These contribute to that TN composite was contain a higher ratio of natural sweeteners with lowering of sourness. The addition of each prebiotic could improve physical and sensory properties of the yoghurt, by stimulating growth of probiotic bacteria (Srisuvor *et al.*, 2013). Moreover, Decourcelle *et al.* (2004) mentioned that conducted those probiotic yoghourts with high level of TN characterized with softness and sweet flavor.

Table (8): Organoleptic evaluation for bio yogurts fortified with 10% JA or TN

Taste parameter	Control	Fortified with *biofedobacterium* and JA	Fortified with *biofedobacterium* and TN
Sourness	6.3± 1.9	6.5± 2.2	5.3± 1.2
Bitterness	4.2± 1.2	3.1± 0.7	2.2± 1.6
Sweetness	2.6± 1.6	4.3± 1.5	5.7± 1.0
Aroma	6.3± 0.8	4.2± 1.7	5.8± 2.1
Overall acceptability	6.7± 0.2	5.3± 1.8	7.1± 1.7

Rheological properties of dough:

~~The results obtained from alveographic measurement of wheat flour (WF) substituted with JA and TN summarized in Table (9). Substitute WF with 5, 10 and 15% of JA or TN evaluated as weaker with lower tenacity and baking strength parameters. Wheat flour is able to form cohesive dough having viscoelastic properties and possessing the ability to retain gas, which is essential for the production of bakery products with a light texture. Whereas, doughs prepared from these flours at different ratio of substitutions did not have optimal viscoelastic~~ **~~Table (9): Rheological properties of wheat flour (WF) dough supplemented with different concentration of JR or TN~~**

physical and sensory properties of the yoghurt, by stimulating growth of probiotic bacteria (Srisuvor *et al*., 2013). Moreover, Decourcelle *et al*. (2004) mentioned that conducted those probiotic yoghourts with high level of TN characterized with softness and sweet flavor.

Rheological properties of dough:

The results obtained from alveographic measurement of wheat flour (WF) substituted with JR and TN summarized in Table (9). Substitute WF with 5, 10 and 15% of JR or TN evaluated as weaker with lower tenacity and baking strength parameters. Wheat flour is able to form cohesive dough having viscoelastic properties and possessing the ability to retain gas, prepared from these flours at different ratio of substitutions did not have optimal viscoelastic behavior, as described by the lower in Configuration rate (P/L) percentage. These results are presented the dough rheological behavior during fermentation and baking. Therefore, the Alveograph device allows the measurement of gluten deformation. Its mode of deformation is similar to the extension that takes place during fermentation and oven rise.

The baking strength representing the energy necessary to inflate the dough bubble to the point of rupture ranged from 160 in the control wheat flour (100%) to 36.0 in the ratio 15 % TN substitution in WF. Such a weakening tendency of the dough for blends ~~JA~~ JR or TN with flours substitution with low tenacity values is characteristics to the presence of a low molecular weight dextrin produced by hydrolyses of damaged wheat flour starch during fermentation assay. Generally, elastic modulus, extendibility, index of swelling, baking strength, configuration rate were lower than present in control 100% wheat flour. Wang *et al*. (2002) reported a decrease in dough elasticity, determined by a farinograph test, upon addition of 3% chicory inulin (Collar *et al*. 2007). The addition of 10 and 15% of ~~JA~~ JR or TN has produced worst quality of dough elasticity and extensibility. This result is worth mentioning that addition ratio of ~~JA~~ JR and TN at 5% have a little closest of Alveograph parameters with 100% wheat flour dough.

Microbiological evaluation:

Effect of *JR* and *TN* on some probiotic bacteria in *vitro*:

The results recorded in Table (10) clearly showed that JR at concentration 10% encouraged growth of *L. plantarum* ; *L. curvatus* and *B.*

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted: Left-to-right
Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Justify Low
Formatted: Justify Low, Indent: First line: 0.95 cm, Line spacing: single
Formatted: Justify Low, Line spacing: single
Formatted: Justify Low, Indent: First line: 1 cm
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
Formatted: Justify Low
...rmatted
...rmatted
Formatted: Left-to-right
...rmatted

subtilis in enrichment broth medium and following by increasing counts of *L. plantarum* from 4×10^{13} to 3×10^{17}, *L.*

Flour alveograph properties	WF	JA			TN		
	100%	5%	10%	15%	5%	10%	15%
Tenacity (P) mm H_2O	85.7	76.0	54.0	38.00	89.0	44.00	46.00
Extensibility (L) mm	53.1	46.0	41.0	29.00	29.0	32.0	18.0
Index of swelling (G)	17.2	15.1	14.3	12.0	12.0	12.6	9.4
Baking strength (W)10E-4 J	160.8	151.0	94.00	46.0	113.0	57.00	36.0

curvatus from 4×10^{13} to 4×10^{17} and *B. subtilis* from 4×10^{11} to 4×10^{16} cfu/ml, while TN at concentration 10 % increased counts of *L. plantarum* from 4×10^{13} to 8×10^{16}, *L. curvatus* from 4×10^{13} to 4×10^{17} and *B. subtilis* from 4×10^{11} to 13×10^{16} cfu/ml in enrichment broth medium. The concentration 10 % of JR or TN represented the optimum concentration for enhancing the growth of the three-probiotic strains and led to decreasing pathogenic bacteria by reduction acidity. Fortified yoghurt by JR or TN, improved carbohydrate content and prebiotic inulin, which contributed to increase activity of *Lactobacillus plantarum* and

Table 9. Rheological properties of wheat flour (WF) dough supplemented with different concentration of JR or TN

Configuration rate (P/L) %	1.77	1.65	1.32	1.31	3.07	1.38	2.56
Elasticity index (Ie) %	75.6	60.00	51.4	45.20	55.6	43.8	36.15

Table 10. Effect of JR and TN on some probiotic bacteria counts *in vitro*

	Treatments*			
without	**JR**		**TN**	
	5%	**10%**	**5%**	**10%**
L. plantarum 7×10^{13}cfu/ml	2×10^{15}	3×10^{17}	3×10^{16}	8×10^{16}
L. curvatus 9×10^{13}cfu/ml	3×10^{16}	4×10^{17}	5×10^{16}	4×10^{17}
B. subtilis 9×10^{11}cfu/ml	5×10^{14}	4×10^{16}	10×10^{14}	13×10^{16}

***The used inoculum of *L. plantarum* was 4×10^{13}cfu/ml; *L. curvatus* was 4×10^{13}cfu/ml and *B. subtilis* was 4×10^{11}cfu/ml**

Microbiological evaluation:

Effect of *JAR* and *TN* on some probiotic bacteria in *vitro*:

The results recorded in Table (10) clearly showed that JAR at concentration 10% encouraged growth of *L. plantarum* P ; *L. curvatus* L.C and *B. subtilis* sub in enrichment broth medium and following by increasing counts of *L. plantarum* LP from 4×10^{12} to 3×10^{17}, *L.* LC from 4×10^{13} to 4×10^{17} and BS from 4×10^{11} to 4×10^{16} cfu/ml, while TN at concentration 10 % increased counts of *L.P.* from 4×10^{12} to 8×10^{16}, *L.C.* from 4×10^{13} to 4×10^{17} and *B. sub* from 4×10^{11} to 13×10^{16} cfu/ml in enrichment broth medium. The concentration 10 % of JA or TN represented the optimum concentration for enhancing the growth of the three-probiotic strains and led to decreasing pathogenic bacteria by reduction acidity. Fortified yoghurt by JA or TN, improve carbohydrate content and prebiotic inulin, which is contribute to increase activity of *Lactobacillus plantarum* and *Lactobacillus curvatus* than control yoghurt. This also recorded by **Buriti *et al.* (2010a)** and **Komatsu *et al.*, 2013**).

Table (9): Rheological properties of wheat flour (WF) dough supplemented with different concentration of JA or TN

Microbiological evaluation:

Effect of *JA* and *TN* on some probiotic bacteria in *vitro*:

The results recorded in Table (10) clearly showed that JA at concentration 10% encouraged growth of L.P ; L.C and B. sub in enrichment broth medium and following by increasing counts of LP from 4×10^{13} to 3×10^{17}, LC from 4×10^{13} to 4×10^{17} and BS from 4×10^{11} to 4×10^{16} cfu/ml, while TN at concentration 10 % increased counts of *L.P.* from 4×10^{12} to 8×10^{16}, *L.C.* from 4×10^{13} to 4×10^{17} and *B. sub* from 4×10^{11} to 13×10^{16} cfu/ml in enrichment broth medium. The concentration 10 % of JA or TN

represented the optimum concentration for enhancing the growth of the three-probiotic strains and led to decreasing pathogenic bacteria by reduction acidity. Fortified yoghurt by JA or TN, improve carbohydrate content and prebiotic inulin, which is contribute to increase activity of *Lactobacillus plantarum* and *Lactobacillus curvatus* than control yoghurt. This also recorded by **Buriti *et al.* (2010a)** and **Komatsu *et al.*, 2013**).

Table (10): Effect of JA JR and TN on some probiotic bacteria counts *in vitro*

	Treatments*			
	JAJR		**TN**	
Controlwithout	**5%**	**10%**	**5%**	**10%**
L. plantarum **L.P** 7×10^{15}cfu/ml	2×10^{15}	3×10^{17}	3×10^{16}	8×10^{16}
L. curvatus **L.C** 9×10^{15}cfu/ml	3×10^{16}	4×10^{17}	5×10^{16}	4×10^{17}
B. subtilis **B. sub** 9×10^{11}cfu/ml	5×10^{14}	4×10^{16}	10×10^{14}	13×10^{16}

Lactobacillus curvatus than control yoghurt. This also recorded by Buriti *et al.* (2010a) and Komatsu *et al.* (2013).

*The used inoculum of *L. plantarum* *L. P* was 4×10^{13}cfu/ml; *L. curvatus* *L. C* was 4×10^{13}cfu/ml and *B. subtilis* *B. sub* was 4×10^{11}cfu/ml

curvatus from 4×10^{13} to 4×10^{17} and *B. subtilis* from 4×10^{11} to 4×10^{16} cfu/ml, while TN at concentration 10 % increased counts of *L. plantarum* from 4×10^{13} to 8×10^{16}, *L. curvatus* from 4×10^{13} to 4×10^{17} and *B. subtilis* from 4×10^{11} to 13×10^{16}cfu/ml in enrichment broth medium. The concentration 10 % of JR or TN represented the optimum concentration for enhancing the growth of the three-probiotic strains and led to decreasing pathogenic bacteria by reduction acidity. Fortified yoghurt by JR or TN, improved carbohydrate content and prebiotic inulin, which contributed to increase activity of

Lactobacillus plantarum and *Lactobacillus curvatus* than control yoghurt. This also recorded by Buriti *et al.* (2010a) and Komatsu *et al.*, (2013).

Effect of JA JR and TN on growth and survival of *Staph aureus* in *vitro*:

The obtained results in Table (11) showed that, JA JR and TN at concentration 10.0 % resulted in decrease of *Staph aureus* counts from 7×10^{13} to 6×10^{7} and 5×10^{6}cfu/ml, respectively in *vitro* and to 9×10^{4} and 7×10^{3} cfu/g, respectively in yoghurt. On the other hand, non-fortified yoghurt samples showed reduced *Staph aureus* counts from 7×10^{13} to 2×10^{9} cfu/g, this these results in agreement with the studies of Mattila –Sandholm *et al*. (2002) and Dimitroglou *et al*. (2011) which recorded that, probiotics are prevent and control of pathogenic microorganisms as an alternative against traditional disease control such as chemotherapeutic agents or vaccines (Dimitroglou *et al.* 2011). The addition of each prebiotic could improve physical and sensory properties of the yoghurt, by stimulating growth

probiotic bacteria (Srisuvor *et al.* 2013). Inulin addition to co-cultures and cocktail enhanced products firmness, either after 1 day or 7 days of cold storage, likely due to the increase in microbial growth induced by metabolic interactions among lactic acid bacteria and partial inulin metabolization (Oliveira *et al.* 2011). Stimulatory effect of inulin on the growth of *bifidobacteria* and lactobacilli (Akalin *et al.* 2004), has recently been described to greater release in yoghurt of additional nutrients (Makras et al. 2005). Moreover, probiotics can inhibit pathogen multiplication , where low numbers of *Lactobacillus delbrueckii* would help the survival of probiotic organisms due to reduced risks of post acidification by *Lactobacillus delbrueckii* (Shah 1995). In addition, inulin powder improved *Lactobacillus casei* growth during fermentation and their survival during storage time (Aryana and McGrew 2007), higher counts of probiotic bacteria in yoghurts with medium and long Chain inulin than those with oligofructose at the end of storage (Lankaputhra *et al.* 1996).

~~agents or vaccines. Moreover, probiotics can inhibit pathogen multiplication , where low numbers of *Lactobacillus delbrueckii* would help the survival of probiotic organisms due to reduced risks of post acidification by *Lactobacillus delbrueckii* (Shah, 1995). In addition, inulin powder improved *Lactobacillus casei* growth during fermentation and their survival during storage time (Aryana and McGrew, 2007). The supplementation of Jerusalem artichoke inulin resulted in greater growth rates of *Lactobacillus casei* than *Bifidobacterium bifidum* and *Lactobacillus acidophilus* during cold storage of yoghurt (Paseephol and Sherkat, 2009). The mechanism by which inulin improve the viability of the probiotic organisms during cold storage is still unclear, while the two possible mechanisms proposed so far state that inulin's provide additional nutrients for promoting culture growth (Makras *et al.*, 2005), and that they protect probiotic cells from acid injury (Desai *et al.*, 2004).~~

Table (11): Effect of ~~JA~~ JR and TN on growth and survival of *Staph aureus* *in vitro*

~~Control~~without	Treatments*			
	~~JA~~JR		TN	
	5.0%	10.0%	5.0%	10.0%
In vitro 9 ×-10^{13}cfu/ml	3 × 10^{9}	6 × 10^{7}	4 × 10^{7}	5 × 10^{6}
Yoghurt 2 ×-10^{9}cfu/g	4 × 10^{6}	9 × 10^{4}	3× 10^{4}	7× 10^{3}

***The used inoculum for *Staph aureus* was 7 x 10^{13}cfu/ml**

~~agents or vaccines (Dimitroglou *et al.* 2011). The addition of each prebiotic could improve physical and sensory properties of the yoghurt, by stimulating growth probiotic bacteria (Srisuvor *et al.* 2013). Inulin addition to co-cultures and cocktail enhanced products firmness, either after 1 day or 7 days of cold storage, likely due to the increase in microbial growth induced by metabolic interactions among lactic acid bacteria and partial inulin metabolization (Oliveira *et al.* 2011). Stimulatory effect of inulin on the growth of~~

bifidobacteria and lactobacilli (Akalin *et al.*, 2004), has recently been described to greater release in yoghurt of additional nutrients (Makras et al, 2005). Moreover, probiotics can inhibit pathogen multiplication , where low numbers of *Lactobacillus delbrueckii* would help the survival of probiotic organisms due to reduced risks of post acidification by *Lactobacillus delbrueckii* (Shah 1995). In addition, inulin powder improved *Lactobacillus casei* growth during fermentation and their survival during storage time (Aryana and McGrew 2007), higher counts of probiotic bacteria in yoghurts with medium and long Chain inulin than those with oligofructose at the end of storage (Lankaputhra *et al.* 1996).

The supplementation inulin from Jerusalem artichoke resulted in greater growth rates of *Lactobacillus casei* than *Bifidobacterium bifidum* and *Lactobacillus acidophilus* during cold storage of yoghurt (Paseephol and Sherkat, 2009). The mechanism by which inulin improve the viability of the probiotic organisms during cold storage is still unclear, while the two possible mechanisms proposed so far state that inulin's provide additional nutrients for promoting culture growth (Makras *et al.* 2005), and that they protect probiotic cells from acid injury (Desai *et al.* 2004). The addition of inulin reduced the fermentation time by about 10.0% as an average, thus confirming its prebiotic effect already evidenced for both *biofidobacteria* and *lactobacilli* by (Donkor *et al.* 2007). The higher microbial growth is one of the causes of a firmness increase in yoghurt (Tamime, 2005), while some other publications by Ozer *et al.* (2005) reported , that inulin didn't support the growth and survival of *L. acidophilus* in fermented bovine milk and acidophilus-bifidus yoghurts.

; Moreover, probiotics can inhibit pathogen multiplication , where low numbers of *Lactobacillus delbrueckii* would help the survival of probiotic organisms due to reduced risks of post acidification by *Lactobacillus delbrueckii*

(Shah, 1995). In addition, inulin powder improved *Lactobacillus casei* growth during fermentation and their survival during storage time (Aryana and McGrew, 2007). The supplementation of Jerusalem artichoke inulin resulted in greater growth rates of *Lactobacillus casei* than *Bifidobacterium bifidum* and *Lactobacillus acidophilus* during cold storage of yoghurt (Paseephol and Sherkat, 2009). The mechanism by which inulin improve the viability of the probiotic organisms during cold storage is still unclear, while the two possible mechanisms proposed so far state that inulin's provide additional nutrients for promoting culture growth (Makras *et al.*, 2005), and that they protect probiotic cells from acid injury (Desai *et al.*, 2004).

CONCLUSION

The results from this study revealed that TN oil contains FA similar of olive oil. Adding JR and TN in bio-yoghurts improve nutritional values, probiotic bacteria and the stability of texture profile, which is desirable to maintain physical-chemical and sensory properties after fermentation and storage period. In addition, substitution of ~~JA~~ JR and TN in white flour WF improve nutritional quality and lowering gluten composite, which is suitable for Celiac disease patients. 10.0% supplementation level of ~~JA~~ JR and TN

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Normal, Justify Low

...rmatted

...rmatted

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

...rmatted

Formatted: Justify Low, Indent: First line: 0 cm

Formatted: Font: (Default) Arial, 13 pt, Complex Script Font: Arial, 13 pt

Formatted: Centered

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Justify Low

resulted in greater rates of probiotic bacteria growth in *vitro*, and showed stronger antimicrobial activity against *Staph aureus* in *vitro* and processed yoghurt. Overall results suggest that JR and TN are a potential functional food ingredient that may be used in food applications.

REFERENCES

AACC, (2000). Approved Methods of the American Association of Cereal Chemist, 10th edn. The American Association of Cereal Chemist, St Paul, MN.

Abrams, S. A., Griffin, I. J., Hawthorne, K. M., Liang, L., Gunn, S. K., Darlington, G., (2005).A combination of prebiotic short- and long-chain inulin-type fructans enhances calcium absorption and bone mineralization in young adolescents. American Journal of Clinical Nutrition, 82, 471-476.

ABRAMS, S. A., GRIFFIN, I. J., HAWTHORNE, K. M., LIANG, L., GUNN, S. K., DARLINGTON, G., ET AL. 2005, A combination of prebiotic short- and long-chain inulin-type fructans enhances calcium absorption and bone mineralization in young adolescents. *American Journal of Clinical Nutrition*, 82, 471-476.

Adejuyitan, J. (2011). Tiger nut processing its food uses and health benefits. American Journal of Food Technology, 6 (3), 197-201.

Aguilar, N., E. Albanell, B. Minarro and M. Capellas, (2015). Chickpea and tiger nut flours as alternatives to emulsifier and shortening in gluten-free bread. LWT-Food Sci. Technol., 62: 225-232.

Akalin A. S., S. Fenderya, and N.Akbulut (2004). Viability and activity of biofidobacteria in yoghurt containing fructooligosaccharide during refrigerated storage. International of Food Science and Technology. 39:613-621. http://dx.doi.org/10.3923/ajft.2011.197.201

AKALIN A. S., FENDERYA S., AKBULUT N. 2004. Viability and activity of biofidobacteria in yoghurt containing fructooligosaccharide during refrigerated storage. *International of Food Science and Technology*. 39,613-621. http://dx.doi.org/10.1111/j.1365-2621.2004.00829.x

AKALIN A. S., GONC S., UNAL G., FENDERYA S. 2007. Effects of fructooligosaccaride and whey protein concentrate on the viability of starter culture in reduce –fat probiotic yoghurt during storage. *Journal of Food Science*, 72, M222-M226. http://dx.doi.org/10.1111/j.1750-3841.2007.00436.x

AKIN, M. B., AKIN, M. S., KIRMACI, Z. 2007. Effects of inulin and sugar levels on the viability of yogurt and probiotic bacteria and the physical and sensory characteristics in probiotic ice cream. Food Chemistry, 104, 93-99. http://dx.doi.org/10.1016/j.foodchem.2006.11.030

Alsmeyer, R.H.; A.E. Cumninghan, and M.L. Happich, (1974). Equations predict PER from amino acid analysis. Food Technol. 7: 34-40.

AOAC, (2012)."Official Methods of Analysis". 19 th ed. Gaithersburg, MD: AOAC International,

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted
Formatted: Left-to-right
Formatted: Font: (Default) Arial, 10 pt, Font color: Red, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 13 pt, Complex Script Font: Arial, 13 pt
Formatted: Centered
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Justify Low
Formatted
Formatted: Font: (Default) Arial, Complex Script Font: Arial
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, Complex Script Font: Arial
Formatted: Justify Low, Indent: Before: 0 cm, Hanging: 1 cm
Formatted
Formatted
Formatted
Formatted
Formatted: Font: (Default) Arial, Complex Script Font: Arial
Formatted: Justify Low
Formatted
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted: Left-to-right
Formatted

Aryana, K., and P. Mcgrew (2007). Quality attributes of yoghurt with Lactobacillus casei and various prepiotics. LWT-Food Science and Technology, 40, 1808-1814.

Alsmeyer, R.H.; Cumninghan, A.E. and Happich, M.L. (1974). Equations predict PER from amino acid analysis. Food Technol. 7: 34-40.

Bourne, M. C. (2002) Food Texture and Viscosity: Concept and Measurement, 2nd edn., Academic Press, San Diego CA.

ARAFAT, S., GAAFAR, A, BASUNY, A., NASSEF, L. 2009. Chufa Tubers (Cyperusesculentus L.): As a New Source Of Food. *World Applied Sciences Journal* 7, 151 - 6.

ARYANA, K., MCGREW, P. 2007. Quality attributes of yoghurt with *Lactobacillus casei* and various prepiotics. *LWT-Food Science and Technology*, 40, 1808-1814.

http://dx.doi.org/10.1016/j.lwt.2007.01.008

BARMINAS, J. T., MANIA, H. M. TAHIR, S., KUBMARAWA, D. , TSWARE, K. 2001. Bioresource Technol., 79,87-80. . http://dx.doi.org/10.1016/S0960-8524(01)00026-8

Belewu, M.A. , and O.A. Abodunrin, O.A. , (2006). Preparation of Kunnu from unexploited rich food source: Tiger Nnut (*Cyperus esculentus*). World J. Dairy Food Sci., 1, : 19- 21.

Belewu, M.A., and K.Y. Belewu, (K.Y. 2007). Comparative Physico-Chemical evaluation of tiger- nut, soybean and coconut milk sources. International Journal of Agriculture and Biology, 5, : 785-787.

Berrang, M. E., ; ; R. J.Buhr , J.R. J., Cason, J., and A. Dickens, A. (2001). Broiler carcass contamination with Campylobacter from feces during defeathering. J. Food Prot., 64, :2063-2066.

Bognar, A. (1992). Determination of vitamin B1 in food by high-performance liquid chromatography and post-column derivatization. Fresenius J Anal Chem, 343:155-156.

Boskou, D.; B. G.Lekas, G., And *M.* Tsimidou *M.* (2005). Phenolic compounds in olive and olives current topics in nutraceuticals Research. 3, :125-136. (Cited from Boskou, D. (2006). Sources of natural phenolic antioxidants. Trend in Food Sci and Technology, 17:505-512.

Bourne, M. C. (2002) Food Texture and Viscosity: Concept and Measurement, 2nd edn., Academic Press, San Diego CA.

Burt, S. (2004). Essential oils: their antibacterial properties and potential applications in foods review. International Journal of Food Microbiology, 94:223-253.

BOURNE, M. C. (2002) Food Texture and Viscosity: Concept and Measurement, 2nd edn., Academic Press, San Diego CA.

http://dx.doi.org/10.1016/j.tifs.2006.04.004).

BOZANIC, R., ROGELJ, I. TRATNIK, L. 2002. Fermentation and storage of probiotic yoghurt from goat milk.Mijekarstvo, 52,93-111.

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted
Formatted: Normal, Justify Low
Formatted
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted
Formatted: Justify Low
Formatted
Formatted
Formatted

Buriti, F.C.A., I.A.Castro, I.A., and S.M.I. Saad S.M.I.(2010). Effects of refrigeration, freezing and replacement of milk fat by inulin and whey protein concentrate on texture profile and sensory acceptance of synbiotic guava mousses. J Food Chem, 23,:1190–1197 http://dx.doi.org/10.1016/j.foodchem.2010.05.085

Burt, S. 2004. Essential oils: their antibacterial properties and potential applications in foods review. International Journal of Food Microbiology, 94, 223-253. http://dx.doi.org/10.1016/j.ijfoodmicro.2004.03.022

Cabezas, M.J., C. Rabert, C., S. Bravo S., and C. Shene (C. 2002). Inulin and Sugar Contents in *Helianthus* tuberosus and Cichorium intybus Tubers: Effect of Postharvest Storage Temperature. Journal of Food Science 67 (8),): 2860–2865, http://dx.doi.org/10.1111/j.1365-2621.2002.tb08829.x

Campos, F. M., S. M. R. Ribeiro, S. M. R., C. M.Della Lucia, ,C. M., H. M.Pinheiro-Sant'ana, H. M., and P. C. Stringheta, (P. C., 2009). Optimization of methodology to analyze ascorbic and dehydroascorbic acid in vegetables. Química Nova, 32(1),):87–91. http://dx.doi.org/10.1590/S0100-40422009000100017

CARABIN, I.G., FLAMM, W.G. 1999. Evaluation of safety of inulin and oligofructose as dietary fiber. *Regulatory Toxicology and Pharmacology* 30, 268–282. http://dx.doi.org/10.1006/rtph.1999.1349

CHINMA, C. E., AVU, J. O., ABUBAKAR, Y. A. 2010. Effect of tigernut (*Cyperus esculentus*) flour addition on the quality of wheat-based cake. *International Journal of Food Science and Technology*, 45, 1746-1752. http://dx.doi.org/10.1007/s11947-011-0712-6

CHUKWUMA, E. R., OBIOMA, N., CHRISTOPHER, O. I. 2010. The phytochemical composition and some biochemical effects of Nigerian tigernut (Cyperus esculentus L.) tuer. *Pak. J. Nutr.* , 9,709–715. http://dx.doi.org/10.1002/ejlt.201300446

Codina-Torrella, I., B.Guamis B., , and A. J. Trujillo, A. J. (2014). Characterization and comparison of tiger nuts (*Cyperus esculentus* L.) from different geographical origin: Physico-chemical characteristics and protein fractionation. Industrial Crops and Products. *11-7.* http://dx.doi.org/10.1016/j.indcrop.2014.11.007

Collar, C., C. Santos Santos, E., , and M Rosell, C. M. (2007). Assessment of the rheological profile of fiber-enriched bread doughs by response surface methodology. Journal of Food Engineering, 78(3),): 820–826, http://dx.doi.org/10.1016/j.jfoodeng.2005.11.026

COSKUNER, Y., ERCAN, R. karababa, E. NAZLICAN A. N. 2002. Physical and chemical properties of chufa (*Cyperus esculentus* L) tubers grown in the Cukurova region of Turkey. *J Sci Food Agric*., 82, 625–631. http://dx.doi.org/ 10.1002/jsfa.1091

Cruz, A.G., R.S.Cadena, ,R.S., E.H.M. Walter, E.H.M., A.M.Mortazavian, A.M., ,, D. Granato, D., J. .A.F. Faria, J. .A.F., and H.M.A. Bolini, H.M.A. (2010). Sensory analysis: relevance for prebiotic, probiotic, and

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
Formatted: Left-to-right
...rmatted
...rmatted
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Justify Low
Formatted: Font: (Default) Arial, Complex Script Font: Arial
...rmatted
Formatted: Justify Low, Indent: Before: 0 cm, Hanging: 1 cm
...rmatted
...rmatted
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
Formatted: Justify Low
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
Formatted: Left-to-right
...rmatted

synbiotic product development. Comprehensive Reviews in Food Science and Food Safety 9(4), 358–373. http://dx.doi.org/ 10.1111/j.1541-4337.2010.00115.x

CUMMINGS, J. H., CHRISTIE, S., COLE, T. J. 2001. A study of fructo oligosaccharides in the prevention of travellers' diarrhoea. *Alimentary Pharmacology and Therapeutics*, 15:1139-1145. http://dx.doi.org/10.1046/j.1365-2036.2001.01043.x

DAVE, R. I., SHAH, N. P. 1996. .Evaluation of media for selective enumeration of *Streptococcus thermophillus*, Lactobacillus *delbrueckii sub sp. bulgaricus, Lactobacillus acidophilus* and *bifidobacteria*. *Journal of Dairy Science*, 79, 1529-1536. http://dx.doi.org/10.3168/jds.S0022-0302(96)76513-X

DE SOUZA OLIVEIRA, R. P.; PATRIZIA, P., DE OLIVERIA, M. N., ATTILIO C. 2011. Effect of inulin as prebiotic and symbiotic interactions between probiotics improve fermented milk firmness. *Journal of Food Engineering*.107, 36-40. http://dx.doi.org/10.1016/j.jfoodeng.2011.06.005

Decourcelle, N., S. Lubbers, , S., N. Vallet, N., P.Rondeau, P., and E. Guichard, (E. 2004). Effect of thickeners and sweeteners on the release of blended aroma compounds in fat-free stirred yoghurt during shear conditions. Int. Dairy J., 14:783–789. http://dx.doi.org/ 10.1016/j.idairyj.2004.02.007

DEMIRKESEN, I., SUMNU G., SAHIN S. 2013. Quality of gluten-free bread formulations baked in different ovens. *Food Bioprocess Tech* 6(3), 746–53. http://dx.doi.org/10.1007/s11947-011-0712-6

Desai, A. R., I. B., Powell, and I. B., N. P. Shah, N. P. (2004).Survival and activity of probiotic lactobacilli in skim milk containing prebiotics. Journal of Food Science, 69, : 57-60. http://dx.doi.org/10.1111/j.1365-2621.2004.tb13371.x

Dimitroglou A., D. L. Merrifield, D. L. O. Carnevali, O. S.Picchietti, S. M.Avelia, , and M. C. Daniels (C. 2011). Microbial manipulations to improve fish health and production a Mediterranean perspective. Fish Shellfish Immunol, 20, : 1-16. http://dx.doi.org/10.1016/j.fsi.2010.08.009

Donkor, O. N., S. L. I. Nilmini, P.Stolic, T. Vasiljevic and N. P. Shah, (2007). Survival and activity of selected probiotic organisms in set-type yoghurt during cold storage. International Dairy Journal, 17: 657-665.

DONKOR, O. N., NILMINI, S. L. I., STOLIC, P. VASILJEVICAND T. SHAH, N. P. 2007.Survival and activity of selected probiotic organisms in set-type yoghurt during cold storage. *International Dairy Journal*, 17, 657-665. http://dx.doi.org/10.1016/j.idairyj.2006.08.006

Dubois, V, S. Breton, , S., M Linder M, J Fanni J, and M.Parmentier M. (2007). Fatty acid profiles of 80 vegetable oils with regard to their nutritional potential. Eur J Lipid Sci Technol 109, : 20–32. http://dx.doi.org/10.1002/ejlt.200700040

Edem, Christopher A. Dosunmu, Miranda, I., Bassey and I.Francesca, I. (2009). Determination of Proximate Composition, Ascorbic Acid and

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Normal, Justify Low
Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
...rmatted
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
...rmatted
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Justify Low
Formatted: Font: (Default) Arial, Complex Script Font: Arial
Formatted: Justify Low, Indent: Before: 0 cm, Hanging: 1 cm
...rmatted
Formatted: Justify Low
Formatted: Font: (Default) Arial, Complex Script Font: Arial
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
Formatted: Justify Low
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted

Heavy Metal Content of African Walnut (Tetracarpidium conophorum).Pak.J. Nutrit. 8, : 225-226. http://dx.doi.org/10.3923/pjn.2009.225.226

Elleuch, M., D.Bedigian, D., O.Roiseux, O., S Besbes S, C.Blecker, C.,and H. Attia H. (2011). Dietary fiber and fiber-rich by-products of food processing: characterization, technological functionality and commercial applications: a review. Food Chem 124, : 411–421. http://dx.doi.org/10.1016/j.foodchem.2010.06.077

ESP´IRITO SANTO A.P., PEREGO, P., CONVERTI A., OLIVEIRA M.N. 2012. Influence of milk type and addition of passion fruit peel powder on fermentation kinetics, texture profile and bacterial viability in probiotic yoghurts. *LWT – Food Sci Technol*47, 393–399. http://dx.doi.org/10.1016/j.lwt.2012.01.038

FAO/WHO, (1991). Protein quality evaluation in human diets. Report of a joint FAO/WHO Expert Consultation. FAO Food and Nutrition paper 51. Food and Agriculture Organization, Rome.

FAO/WHO. 2001. Evaluation of health and nutritional properties of powder milk and live lactic acid bacteria. Food and Agriculture *Organization of the United Nations and World Health Organization Expert Consultation Report* (Available at: http://www.who.int/ food safety/publications/fs_management/en/probiotics.pdf. Last Accessed 19.03.134).

FARNWORTH, E. R. 2008. The evidence to support health claims for probiotics. *Journal of Nutrition*, 138, 1250–1254.

FARNWORTH, E. R., MAINVILLE, I., DESJARDINS, M. P., GARDNER, N., FLISS, I., CHAMPAGNE, C. 2007. Growth of probiotic bacteria and bifidobacteria in a soy yogurt formulation. *International journal of food microbiology*, 116(1), 174–181. http://dx.doi.org/10.1016/j.ijfoodmicro.2006.12.015

Food And and Nutrition Board , (2002). Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. Washington, DC: National Academy Press.

Franck, A. M. E. (2000). Inulin and oligofructose. In G. R. Gibson & F. Angus (Eds.), LFRA ingredient handbook: Prebiotics and probiotics (pp. 1–18). Surrey: Leatherhead Publishing.

FREGA, N., CONTE, L.S., G.LERCKER, CARNACINI A. 1984.Riv. *Soc. Ital. Sci. Aliment*., 13(9): 211–214.

FULLER, R.1992. Probiotics-The scientific basis. Chapman and hall, London.

Gibson, G. R., J H. Probert, M. R. A.J H. Vanloorastall, M. R. A., M. B. Roberfroid M. B. (2004). Dietary modulation of the human colonic microbiota: updating the concept of prebiotics. Nutrition Research Reviews, 17, :259-275 http://dx.doi.org/10.1079/NRR200479

Hashim I.B., A.H Khalil A.H, and H.S. Afifi, H.S. (2009) Quality characteristics and consumer acceptance of yogurt fortified with date fiber .J Dairy Sci 92:5403–5407. http://dx.doi.org/10.3168/jds.2009-2234

HEKMAT, S., SOLTANI, H., REID, G. 2009. Growth and survival of *Lactobacillus reuteri* RC-14 and *Lactobacillus rhamnosus* GR-1 in yogurt for use as a functional food. *Innovative food science & emerging technologies*, 10, 293–296. http://dx.doi.org/10.1016/j.ifset.2008.10.007

Helle Ruresson, Salla Marttila, Karl –Erik Gustavsson, Per Hofvander, (2010). American Journal of Botany 97(11),): 11-15.

Huisman, A., A.Van De Wiel, A., T. J.Rabelink, T. J., and E. E Van Faassen, (E. E. 2004). Wine polyphenols and ethanol do not significantly scavenge superoxide nor affect endothelial nitric oxide production. Journal of Nutritional Biochemistry, 15: 426–432. http://dx.doi.org/10.1016/j.jnutbio.2004.01.006

Igoe, R.S. (1989). Dictionary of Food Ingredients. New York: Vas Nost and Reinhoed.

IIFC, (2004). Background on functional foods. http://www.ific.org/nutrition/functional/ upload/FuncFdsBackgrounder.pdf

JACK, R. W., TAGG J. R. RAY B. 1995. Bacteriocins of gram – positive bacteria.*Microbiological Review.* 59,171-200.

Javier Matías M., José María Encinar J. María Encinar, Jerónimo González J. González , and Rafael R. A. Barrena .(2011). Analysis of sugars by liquid chromatography-mass spectrometry in Jerusalem artichoke tubers for bioethanol production optimization. Energy for Sustainable Development, Biomass and Bioenergy 35, :2006-2012. http://dx.doi.org/10.1016/j.biombioe.2011.01.056

JIA, W., LI, H. K., ZHAO, L. P., NICHOLSON, J. K. 2008. Gut microbiota: a potential new territory for drug targeting. *Nature Reviews Drug Discovery.* 7:123–129. http://dx.doi.org/10.1038/nrd2505

JUSZCZAK L, WITCZAK T, ZIOBRO R, KORUS J, CIE´SLIK E, WITCZAK M. 2012. Effect of inulin on rheological and thermal properties of gluten-free dough. *Carbohydr Polym* 90(1), 353–60. http://dx.doi.org/10.1016/j.carbpol.2012.04.071

KAJIWARA, S., GANDHI, H., USTUNOL, Z. 2002. Effect of honey on the growth of and acid production by human intestinal Bifidobacterium spp.: an in vitro comparison with commercial oligosaccharides and inulin. *Journal of Food Protection* 65, 214–218.

KALYANI NAIR, K., KHARB S. THOMPKINSON D. K. 2010. Inulin dietary fiber with functional and health attributes. A Review. *Food Review International*, 26,189-203. http://dx.doi.org/10.1080/87559121003590664

KANSAL V. K. , SONAL RAJPA 2006. Probiotic dahi: formulation and validation of health-benefits. Center of advances studies, National Dairy Research Institute, dairy technology division, developments in traditional dairy products 21st , karnal (Haryana) India, Page 184-187,

Kathayat, R., A.S.Jaiswal, A.S., S.F., Basir, and S.F., S.K. Bansal, (S.K. 1997). Dietary protein deficiency induced changes in protein kinase C

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Normal, Justify Low

Formatted: Justify Low

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, Complex Script Font: Arial

...rmatted

Formatted: Justify Low, Indent: Before: 0 cm, Hanging: 1 cm, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

Formatted: Justify Low

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

Formatted: Justify Low

...rmatted

...rmatted

...rmatted

activity and phospholipid metabolism in rat hepatocytes. Indian J. Exp. Biol.

https://www.wikigenes.org/e/ref/e/9475078.html

Katsuyama, M, Y. Kobayashi, H Y, Ichikawa H, A Mizuno, A, Y. Miyachi , K Y, Matsunaga K , and M Kawashima M (2005). A novel method to control the balance of skin microflora: Part 2. A study to assess the effect of a cream containing farnesyl and xylitol on atopic dry skin. J. Dermatol. Sci., 38: 207-213.
http://dx.doi.org/10.1016/j.jdermsci.2005.08.003

KENDALL, C. W. C., ESFAHANI, A., JENKINS, D. J. A. 2010. The link between dietary fiber and human health. *Food Hydrocolloids*, 24, 42-48. http://dx.doi.org/10.1016/j.foodhyd.2009.08.002

Kip, P., D. Meyer D., and R.H. Jellema (R.H. 2006). Inulins improve sensory and textural properties of low-fat yoghurts. Int Dairy J., 16, 1098–1103. http://dx.doi.org/10.1016/j.idairyj.2005.10.011

Komatsu , T. R., Flávia C.A. Buriti , Roberta C. Da Silva , Alexandre R. Lobo , Célia Colli ,Luiz A. Gioielli , and Susana M.I. Saad, (2013). Nutrition claims for functional guava mousses produced with milk fat substitution by inulin and/or whey protein concentrate based on heterogeneous food legislations. *LWT* - Food Science and Technology 50, 755-765. http://dx.doi.org/10.1016/j.lwt.2012.07.013

Kubmarawa, D., I. A Ogunwande, I. A. N. D. A Okorie, N. D. A. O. Olawore O., and A. A. Kasali (A. A. 2005). Chemical constituents of the volatile oil of *cyperus Cyperus esculentus* L. from Nigeria Flavour And and Fragrance Journal; 20, 640–641.

Lankaputhra, W.E.V., and N.P Shah,. (1996). A simple method for selective enumeration of Lactobacillus acidophilus in yoghurt supplemented with L. acidophilus and Bifidobacterium spp. Milchwissenschaft 51, 446–451.
http://dx.doi.org/10.1002/ffj.1517

Lambert, R.J.W., P.N. Skandamis, P.N.; P. Coote, P.; and G.J.E. Nychas, (G.J.E. 2001). A study of the minimum inhibitory concentration and mode of action of oregano essential oil, thymol and carvacrol. J. Appl. Microbiol. 91, ; 453–462. http://dx.doi.org/10.1046/j.1365-2672.2001.01428.x

LANDIN, K., HOLM, G., TENGBORN, L., SMITH, U. 1992. Guar gum improves insulin sensitivity, blood lipids, blood pressure, and fibrinolysis in healthy men. American Journal of Clinical Nutrition, 56, 1061-1065.

LANKAPUTHRA, W.E.V., SHAH, N.P. 1996. A simple method for selective enumeration of Lactobacillus acidophilus in yoghurt supplemented with L. acidophilus and Bifidobacterium spp. Milchwissenschaft 51, 446–451. http://dx.doi.org/10.3168/jds

Legault, J. and A. Pichette A. (2007). Potentiating effect of β-caryophyllene on anticancer activity of α-humulene, isocaryophyllene and paclitaxel journal of Pharmacy and Pharmacology. 59, (12), . 59, (12); 1643–1647.

http://dx.doi.org /10.1211/jpp.59.12.0005

LIN, Q., WANG, Q. Y. DUAN, D. WEI, WU, G., LUO, Y., XIE. Q. 2013. Removal of Cu (II), Cr (III), and Cr (VI) from Aqueous Solution using a Novel Agricultural Waste Adsorbent Separation Science and Technology. 48, (18). 2843-2851. http://dx.doi.org /10.1080/01496395.2013.808216

LU, L. WALKER W. A. 2001.Pathologic and physiologic interactions of bacteria with the gastrointestinal epithelium. *Am. J. Cli. Nut.* 73,1124S-1130S.

Luo, X. M., H. J. Wei, H. J. And and S. P. Yang, , (S. P. 1983). Inhibitory Effects of Molybdenum on Esophageal and Forestomach Carcinogenesis in Rats J. Nat. Can. Inst., 71 (1) 75.

http://dx.doi.org /10.1093/jnci/71.1.75

MAKAI, S. BALANTINCZ, J. 2002. Comparative Examination of Biologically Active Compounds of Fatty Oils of Medical and Alternative Herbs Separate by Cold-Moulding. *Pannon University of Agriculture Sciences, Mosonmagyaróvár, Hungary.*

Makras, L. G., and L.Van Acker De Vuyst L., (2005). *Lactobacillus casei subsp. Casei* 8700:2 degrades inulin-type fructans exhibiting different degrees of polymerization. Applied and Environmental Microbiology, 71, : 6531-6537

http://dx.doi.org /10.1128/AEM.71.11.6531-6537.2005

Mano, E. Olsson , Leif B. Ülow, Stenstymne, Anders S. Carlsson Shaker M. Arafat, Ahmed M. Gaafar, Amany M. Basuny And and Shereen L. Nassef, (2009). Chufa Tubers (*cyperuses Cyperuses* L.): As a new source of food, World Applied Sciences Journal 7(2),):151-156.

MANZO, N, FABIANA PIZZOLONGO, IMMACOLATA MONTEFUSCO, MARIA APONTE, GIUSEPPE BLAIOTTA, RAFFAELE ROMANO .2015.The effects of probiotics and prebiotics on the fatty acid profile and conjugated linoleic acid content of fermented cow milk. *Int J Food Sci Nutr*, Feb 6, 1-6.

Masso-Welch, P.A., D.Zangani, D., C.Ip, C., M.M., Vaughan, M.M., S.F., Shoemaker, S.F., S.O., McGee, S.O., and M.M.Ip, M.M. (2004). Isomers of conjugated linoleic acid differ in their effects on angiogenesis and survival of mouse mammary adipose vasculature. J. Nutr. 134:299–307.

http://dx.doi.org /10.3109/09637486.2014.992005

Mattila- Sandholm, T., P. R. Myllarienen, R. G.Crittenden, G. R.Mongesen, R. M.Fonden M. Saareland A.Saarel A. (2002). Technological challenger for future probiotic foods. Int. Dairy J., 12, :173-182.

http://dx.doi.org /10.1016/S0958-6946(01)00099-1

MATTILA, P., J. ASTOLA AND J. KUMPULAINEN, 2000.Determination of flavonoids in plant material by HPLCs with diode - array and electro-array detections. *J. Agric. Food Chem.*, 4(12), 5834-5841. http://dx.doi.org /10.1021/jf000661f

Miller, E. L. (1967). Determination of the tryptophan content in feeding stuffs with particular reference to cereals. J. Sci. Food Agric., 18 (9): 381-386. http://dx.doi.org /10.1002/jsfa.2740180901

Muhammad, N., E. Bamishaiye, E., O. Bamishaiye, O., L. Usman, (L.2011). Physicochemical properties and fatty acid composition of *Cyperus esculentus* (Tiger-Nut) tuber oil. Biores. Bull. 5: 51–54

NEGBI, M. 1992. A sweetmeat plant, a perfume plant and their weedy relatives: a chapter in the history of *Cyperus esculentus L.* and *C. rotundus L.*, *Economic Botany*.46:64-71

NÚRIA AGUILAR, ELENA ALBANELL, BEGOÑA MIÑARRO, MARTA CAPELLAS *.2015.* Chickpea and tiger nut flours as alternatives to emulsifier and shortening in gluten-free bread . *LWT - Food Science and Technology, 62(1), 225-232.* http://dx.doi.org/10.1016/j.lwt.2014.12.045

O'BRIEN, C. M., MUELLER, A., SCANNELL, A. G. M., & ARENDT, E. K. 2003. Evaluation of the effects of fat replacers on the quality of wheat bread. *Journal of Food Engineering*, 56, 265-267.

http://dx.doi.org/10.1016/S0260-8774(02)00266-2

Oliveira, R.P.S., P.Patrizia, P. M. N.Oliveira, M. N., A Converti A. (2011). Effect of inulin as a prebiotic to improve growth and counts of a probiotic cocktail in fermented skim milk. *LWT* - Food Science and Technology 44: 520-523.

Ozer, D., M. S., Akin, and B.Ozer, (2005). Effect of inulin and lactulose on survival of Lactobacillus acidophilus LA-5 and Bifidobacteriumbifidum BB-02 in acidophilusbifidus yoghurt. Food Science and Technology International, 11:19-24. http://dx.doi.org/10.1016/j.lwt.2010.08.024

OZER, D., AKIN, M. S., OZER, B. 2005. Effect of inulin and lactulose on survival of *Lactobacillus acidophilus LA-5* and *Bifidobacteriumbifidum* BB-02 in acidophilusbifidus yoghurt. *Food Science and Technology International*, 11, 19-24. http://dx.doi.org/10.1177/1082013205051275

PARAMESWARAN, M. 1994. *Jerusalem artichoke*: Turning an unloved vegetable into an industrial crop. *Food Australia*, 46,473-475.

Paseephol, T., and F. Sherkat F. (2009). Probiotic stability of yoghurts containing *Jerusalem artichoke* inulin during refrigerated storage .Journal Of Functional Foods 1: 311-318.

PIAD, R., SAMANIEGO, L. M. PÉREZ, M. BOUCOURT, R. MEDINA, E. LAURENCIO M., MILIAN G. 2006. Prebiotic activity of enzymatic yeast cream hydrolyzate on egg-laying hen's productive indicator. *Ciencia Tecnologia Alimentaria* .5, 226-230

http://dx.doi.org/10.1080/11358120609487695

PIERONI, A. 2000. Medicinal plants and food medicines in the folk traditions of the upper Lucca Province, Italy. *Journal of Ethno pharmacology* 70,235-273. http://dx.doi.org/ 10.1016/S0378-8741(99)00207-X

PIMENTEL, T.C., CRUZ, A.G., PRUDENCIO, S.H. 2013. Short communication: Influence of long-chain inulin and *Lactobacillus paracasei* subspecies paracasei on the sensory profile and acceptance of a traditional yogurt. *J. Dairy Sci.*, *96*, 6233–6241.

http://dx.doi.org/10.3168/jds.2013-6695

Pinheiro, R., Pergo, P., Converti, A., Nogueira, M. (2009). The effect of inulin as a prebiotic on the production of probiotic fiber-enriched fermented milk. International Journal of Dairy Technology, 62, 195-203.

http://dx.doi.org/10.1111/j.1471-0307.2009.00471.x

POLAKI, A., XASAPIS, P., FASSEAS, C., YANNIOTIS, S., MANDALA, I. 2010. Fiber and hydrocolloid content affect the microstructural and sensory characteristics of fresh and frozen stored bread. *Journal of Food Engineering*, 97, 1-7.

http://dx.doi.org/10.1016/j.jfoodeng.2009.04.031

Reimer, R. A., and J. C. Russell, (2008). Glucose tolerance, lipids, and GLP-secretion in JCR: LA-cr Ratf Fed h High Protein Fiber Diet. Obesity, 16: 40-46.REIMER, R. A., & RUSSELL, J. C. 2008. Glucose tolerance, lipids, and GLP- secretion in JCR: LA-cr Ratf Fed h High Protein Fiber Diet. *Obesity*, 16, 40-46. http://dx.doi.org/10.1038/oby.2007.16

ROBERFROID, M. B. 2001. In: Gibson GR, Williams CM (eds) *Functional foods. Concept to product.Woodhead, Cambridge, UK*, pp 9–28

ROBERFROID, M.B. 2000. Defining functional foods. In: Gibson, G.R., Williams, C.M. (Eds.), Functional Foods: Concept to Product. CRC Press, Boca Raton, USA, pp. 9– 27 (Chapter 1).

RODGERS, S. 2008. Novel applications of live bacteria in food services: Probiotics and protective cultures. *Trends in Food Science & Technology*. **19**(4), 188–197.

http://dx.doi.org/10.1016/j.tifs.2007.11.007

RODRIGUES, D., ROCHA-SANTOS, T. A. P., PEREIRA, C. I., GOMES, A. M., MALCATA, F. X., AND FREITAS, A. C. 2011. The potential effect of FOS and inulin upon probiotic bacterium performance in curdled milk matrices. *Food Science and Technology*, 44, 100-108. http://dx.doi.org/10.1016/j.lwt.2010.05.021

RUAS-MADIEDO, P., TUINIER, R., KANNING, M., AND ZOON, P. 2002. Role of exopolysaccharides produced by *Lactococcus lactis subsp. cremoris* on the viscosity of fermented milks. *International Dairy Journal* 12, 689–695. http://dx.doi.org/10.1016/S0958-6946(01)00161-3

Rumessen, J. J., S.Bod, S., O. Hamberg, H O. Gudm_and H. E.Yer, (E. 1990). Fructans of *Jerusalem artichokes*: Intestinal transport, absorption, fermentation, and influence on blood glucose, insulin, and c-peptide responses in healthy subjects. American Journal of Clinical Nutrition, 52(4),): 675-681.

Salwa M. El-Shebini, M.D.; I.A. Maha M.D.Moaty.; Salwa T. Tapozada, M.D.; Laila M. Hanna, Ph.D.; Hamed I. Mohamed, Ph.D. M.Hala and M.D. Raslan, (2010). Effect of Regular Consumption of Tiger Nut (Cyperus esculentus) on insulin resistance and tumor necrosis factor-alpha in obese type 2 diabetic Egyptian women. Med. J. Cairo Univ., 78, 2(12), 607-614.

Shah, N. P. (1995). Urvival of Lactobacillus acidophilus and Bifidobacterium in commercial yoghurt during refrigerated storage. International Dairy Journal, 5,515-521.

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Normal, Justify Low
Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic
Formatted: Font: (Default) Arial, Complex Script Font: Arial
Formatted: Justify Low, Indent: Before: 0 cm, Hanging: 1 cm
...rmatted
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, Complex Script Font: Arial
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
...rmatted
Formatted: Justify Low
...rmatted
Formatted: Justify Low, Indent: Before: 0 cm, Hanging: 1 cm
Formatted: Font: (Default) Arial, Complex Script Font: Arial
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Justify Low
Formatted: Justify Low, Indent: Before: 0 cm, Hanging: 1 cm
Formatted: Justify Low
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, Complex Script Font: Arial
...rmatted
...rmatted
...rmatted
...rmatted

Shori, A.B., A.S Baba., (2011).Comparative antioxidant activity,proteolysis and in vitro α-amylase and glucosidase inhibition of Allium sativum-yogurts made from cow and camel milk, Journal of Saudi Chemical Society http://dx.doi.org/10.1016/j.jscs.2011.09.014.

Srisuvor, N.; C.Ninnart, , P.Cheunjit, and S.Suwanna (2013). Effect of inulin and polydextose on physicochemical and sensory properties of low – fat set yoghurt with probiotic-cultured banana pure. *LWT*, Food Science and Technology. 51, 30-36.

Temple, V. J., T. O. Ojebe and M. M. Kapu (1989). Chemical analysis of tiger nut (*Cyperus esculentus*). J. Sci. Agric. 49:261-262.

Tamime, A. Y., M. Saarela, A. K.Søndergaard, , V. V. Mistry, and N. P. Shah, (2005). Production and maintenance of viability of probiotic micro-organisms in dairy products. In A. Y. Tamime (Ed.), Probiotic dairy products (pp. 39-72). Oxford: Blackwell.

Turhan, M., S. Sayarand, and S Gunasekaran., (2002). Application of Peleg model to study water absorption in chickpea during soaking. Journal of Food Engineering, 53, 153–159.

Wang, J., C. M., Rosell, and C. Benedito de Barber, (2002). Effect of the addition of different fibers on wheat dough performance and bread quality. Food Chemistry, 79(2): 221–226.

WHO , (1985). WHO/FAO Report: Energy and Protein Requirements.WHO Technical Report Series No. 724. World Health Organization Geneva.

Yang, D. L. Michel, J.P. Chaumont and J..Millet-Clerc (1999).Use of caryophyllene oxide as an antifungal agent in an in vitro experimental model of onychomycosis. Mycopathologia, 148: 79-82.

SALWA M. EL-SHEBINI, M.D.; MAHA I.A. MOATY, M.D.; SALWA T. TAPOZADA, M.D.; LAILA M. HANNA, PH.D.; HAMED I. MOHAMED, PH.D. HALA M. RASLAN, M.D. 2010. Effect of Regular Consumption of Tiger Nut (*Cyperus Esculentus*) on insulin resistance and tumor necrosis factor-alpha in obese type 2 diabetic Egyptian women. *Med. J. Cairo Univ.*, 78, 2(12), 607-614.

SHAH, N. P. 1995. Urvival of *Lactobacillus acidophilus* and *Bifidobacterium* in commercial yoghurt during refrigerated storage. *International Dairy Journal*, 5,515-521. http://dx.doi.org/10.1016/0958-6946(95)00028-2

SHORI, A.B., BABA A.S. 2011.Comparative antioxidant activity,proteolysis and *in vitro* α-amylase and _-glucosidase inhibition of *Allium sativum*-yogurts made from cow and camel milk, Journal of Saudi Chemical Society http://dx.doi.org/10.1016/j.jscs.2011.09.014.

SRISUVOR, N.; NINNART, C., CHEUNJIT P., SUWANNA S. 2013. Effect of inulin and polydextose on physicochemical and sensory properties of low – fat set yoghurt with probiotic-cultured banana pure. *LWT. Food Science and Technology*. 51, 30-36 http://dx.doi.org/10.1016/j.lwt.2012.10.018

STAFFOLO, M. D., BERROL N., MARTINO A M., BEVILACQUA Y. A. 2004. Influence of dietary fiber addition on sensory and rheological properties of yogurt. *International Dairy Journal*, 14(3), 263-268. http://dx.doi.org/10.7763/IJCEA.2014.V5.417

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic
...rmatted
Formatted: Left-to-right
...rmatted
Formatted: Font: 10 pt, Complex Script Font: 10 pt
...rmatted
...rmatted
...rmatted
...rmatted
...rmatted
Formatted: Font: (Default) Arial, Complex Script Font: Arial
...rmatted
Formatted: Justify Low
Formatted: Font: Arial, 10 pt, Complex Script Font: 10 pt
Formatted: Justify Low, Indent: Hanging: 1 cm, Space Before: 0 pt, After: 0 pt, Line spacing: single, Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers
...rmatted
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: (Default) Arial, Complex Script Font: Arial
Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt
Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold
Formatted: Left-to-right
Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold

TAMIME, A. Y., SAARELA, M., SØNDERGAARD, A. K., MISTRY, V. V., SHAH, N. P. 2005.Production and maintenance of viability of probiotic micro-organisms in dairy products. In A. Y. Tamime (Ed.), *Probiotic dairy products* (pp. 39-72). Oxford: Blackwell.

Temple, V. J. , Ojebe T. O. and Kapu M. M. (1989). Chemical analysis of tiger nut (Cyperus esculentis). J. Sci. Agric. 49:261-262.

TURHAN, M., SAYARAND S., GUNASEKARAN, S. 2002. Application of Peleg model to study water absorption in chickpea during soaking. *Journal of Food Engineering*, 53, 153–159.

http://dx.doi.org/10.1016/S0260-8774(01)00152-2

UMERI, S.C., ENEBELI, J.N. 1996. Malt caramel from tubers of *Cyperus esculentus*. *Bioresource Technol.* 57, 215–216.

http://dx.doi.org/ 10.1016/0960-8524(96)00068-5

VENTURA, M., O'FLAHERTY, S., CLAESSON, M. J., TURRONI, F., KLAENHAMMER, T. R., VAN SINDEREN, D., O'TOOLE, P. W. 2009. Genome-scale analysis of health-promoting bacteria: Probiogenomics. *Nature Reviews Microbiology*. **7**, 61–71.

Wang, J., Rosell, C. M., and Benedito de Barber, C. (2002). Effect of the addition of different fibers on wheat dough performance and bread quality. Food Chemistry, 79(2): 221–226.http://dx.doi.org/10.1038/nrmicro2047

WHIGHAM, L. D., WATRAS, A. C., & SCHOELLER, D. A. 2007. Efficacy of conjugated linoleic acid for reducing fat mass: A meta-analysis in humans.*American Journal of Clinical Nutrition*, 85(5), 1203–1211.

WHO .1985. WHO/FAO Report: Energy and Protein Requirements.WHO Technical Report Series No. 724. World Health Organization Geneva.

YANG, D, MICHEL L, CHAUMONT J-P MILLET-CLERC J.1999. Use of caryophyllene oxide as an antifungalagent in an *in vitro* experimental model of onychomycosis. *Mycopathologia*, 148, 79-82. http://dx.doi.org/10.1111/j.1365-2133.2011.10303.x

YONG, M A, X. , L. H. ZHANG , H. B. SHAO, G. XU, F. ZHANG, BRESTIC F. T. M. 2011. *Jerusalem artichoke* (*Helianthus tuberosus* L.), a medicinal salt-resistant plant has high adaptability and multiple-use values. *Journal of Medicinal Plants Research*, 5(8), 1272.

YUAN, X.Y., GAO, M.Z. XIAO, H.B., TAN, C.Y. DU, Y.G. 2012. Free radical scavenging activities and bioactive substances of *Jerusalem artichoke (Helianthus tuberosusL.)* leaves, *J. Food Chem*. 133,10- 14. http://dx.doi.org/10.1016/j.foodchem.2011.09.071

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Normal, Justify Low

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Font: (Default) Arial, Complex Script Font: Arial

Formatted: Font: Arial, 10 pt, Complex Script Font: 10 pt

Formatted: Font: (Default) Arial, Complex Script Font: Arial

Formatted: Font: Arial, 10 pt, Complex Script Font: 10 pt

Formatted: Font: (Default) Arial, Complex Script Font: Arial

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, Complex Script Font: Arial

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, Complex Script Font: Arial

Formatted: Font: Arial, 10 pt, Complex Script Font: 10 pt

Formatted: Font: (Default) Arial, Complex Script Font: Arial

Formatted: Font: Arial, 10 pt, Complex Script Font: 10 pt

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Font: (Default) Arial, 10 pt, Complex Script Font: Arial, 10 pt

Formatted: Justify Low

Formatted: Font: (Default) Arial, 13 pt, Complex Script Font: Arabic Transparent, 13 pt

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Left-to-right

Formatted: Font: 9 pt, Italic, Complex Script Font: 9 pt, Italic

Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold

Formatted: Left-to-right

Formatted: Font: Arial, 10 pt, Bold, Complex Script Font: 10 pt, Bold

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Normal, Justify Low

Formatted: Font: Arial, 9 pt, Bold, Italic, Complex Script Font: 9 pt, Bold, Italic

Formatted: Font: (Default) Arial, 13 pt, Complex Script Font: Arabic Transparent, 13 pt

Formatted: Justify Low, Space Before: 0 pt, After: 0 pt, Line spacing: single

Formatted: Font: (Default) Arial, 13 pt, Complex Script Font: Arabic Transparent, 13 pt

...rmatted

...rmatted

...rmatted

...rmatted

...rmatted

الملخص العربي

تأثير إستخدام المصادر السكرية لنباتي الطرطوفة وحب العزيز كمواد بروبيوتيك في بعض الأغذية الوظيفية من الزبادي والعجائن على نمو البكتريا المرضية وبكتريا البروبيوتيك الممرضات الغذائية بدراسة ميكروبيولوجية وتغذوية

وائل حلمي موسى الرفاعي و أحمد فريد سالمعبد السلام و، عادل محمد محمد القرمدي و
إيمان محمد راغب

المركز الاقليمي للاأغذية والاأعلاف – مركز البحوث الزراعية

الملخص العربي

لتحسين النتاج أغذية محتوية علي البروبيوتيك تطرقت هذة الدراسة الحالي امكانية أستخدام المصادر السكرية لكلا من نباتي الطرطوفة وحب العزيز كمصادر لاولية للبريبيوتيك وتقييم لاداء النتاجها ونموها في الأغذية المتخمرة كالزبادي والعجائن ومدي تلأثيرها على حفظ تلك المنتجات من خلال تقييم جودتها المختلفة وكذلك مستوي البكتريا الممرضة في تلك الاغذية ومدي الإقاف وتثبيط بكتريا الإلإستاف الممرضة . ويعد الألينيولين المتوافر في الطرطوفة من لأهم المواد التي لها دور

وظيفى كبريبيوتيك مسببة لنشاط البكتريا المفيدة صحيا وتغذويا. وكذلك تم التطرق إللى كل مكونات تلك النباتات كيماويا وتحديد المغذيات الكبري والصغري من مطحوتهابعد معاملة حب العزيز بالنقع والتجفيف.

تـم تقـدير محتواهمـا مـن اللألحمـاض الأمينيـة والأحمـاض الدهنيـة والتحليـل الكروماتوجرافى الكتلى وتركيب السكريات المختلفة واستخدم إلضافات للعجائن بنسب مختلفة من كلا الدرنات بعد طحنها فى إلنتاج عجائن تتميز بانخفاض مستوي الجلوتين الذي يناسب بعض المرضي سواء مرضي السكر لأو مرضـي السيلك . وقد تم التحاليل الميكروبيولوجية على البكتريا سواء المنشطة من البروبيوتيك او الممرضة والمسببة لفساد الأغنية من بكتريا الإستاف للاستاف فى الزبادي المدعم بكلا المصادر من الدرنات محل الدراسة . وقد اظهرت الدراسة إلى من ألمكانية إلستخدام تلك الدرنات في إليجاد لأغنية وظيفية لبعض المرضي والحالات الغذائية فيفضلا عن إليجاد مصدر إلقتصادي لتلك الأغنية الوظيفية.