Improve Sensory Quality and Textural Properties of Fermented Camel's Milk By Fortified With Dietary Fiber

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Abstract: Both camel's milk and dietary fibers itself are well known for their beneficial health effects, and together they may constitute a functional food with commercial applications. This study investigated the effects of addition of date and orange fibers obtained from juice and date syrup by-products at three different ratios (1.5, 3 and 4.5%) on physiochemical properties, colour parameters [L* (lightness), a* (redness) and b* (yellowness) values] and sensory evaluation of camel's yoghurts during 21d of storage period at (4 ±1°C). Results given revealed that, the addition of orange fibers had significant (*P<0.05*) effect on pH-value and titratable acidity %. At the end of the storage period the highest acidity 1.28±0.01% and lower pH 4.57±0.09 was recorded in yoghurts fortified with 4.5% orange fiber. Moreover, yoghurts fortified with 4.5% orange fiber had significantly (*P<0.05*) higher L* and b* and lower in a* values when compared with yoghurts fortified with date fiber. Furthermore, the incorporation of either orange or date fibers in camel's yoghurt formulation resulted in an increase in product firmness and viscosity in comparison with the control samples but, the highest (*P<0.05*) viscosity, firmness and lowest syneresis values were found in the yoghurt fortified with 4.5% orange fiber throughout storage period. Also, orange fiber presence in camel's yoghurt enhanced bacterial growth and survival of *S. thermophiles* and probiotic bacteria (*Lb. acidophilus* and *B. animalis subsp. Lactis)* through whole period of storage. Sensory analysis results indicated that 4.5% orange fiber is an ideal amount to add in camel's yoghurt production. Panelists gave the highest flavor, texture, appearance and overall acceptability scores to the yoghurt fortified with orange fiber.

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1. Introduction:

The dromedary camel (*Camelus dromedarius*) is one of the most important domesticated animals in the arid and semiarid zones of tropical and sub-tropical countries. Camel milk and its products are a good nutritional source for human diet in many parts of the world as they contain all essential nutrients **Al Haj and Al Kanhal, (2010)**. It has queer characteristics which are much different from other mammals milk such as it has high level of insulin, immunoglobulins, vitamins and minerals **Abbas et al., (2013)** and **Konuspayeva et al., (2007)**. Additionally, a number of researchers reported the healthy benefits of camel's milk in particular for anticarcinogenic **Magjeed, (2005)** and antidiabetic **Agrawal et al., (2007)**, and has been recommended to be consumed by children who are allergic to bovine milk **(El-Agamy et al., 2009)**.

However, the processing of camel milk into fermented milk is technically more difficult than milk from other domestic dairy animals. **Jumah et al., (2001)** reported that camel milk viscosity was not changed during gelation process of yoghurt. This is mainly due to its low total solids content, unique composition and casein properties. Camel's milk has slightly lower casein content than cow's milk, with a very low ratio of beta-CN to kappa-CN than in cow milk **Kappeler et al., (1998)**. Also, this may be because camel milk contains a greater content of antimicrobial components such as lysozyme, lactoferrin and immunoglobulins than do bovine or buffalo milk **(Benkerroum, 2008** and **Konuspayeva, et al., 2007)**. All these factors influence the rheological properties of the heat treatment and acidic coagulation in camel's milk that is almost semi liquid.

Recently, there are some attempts to improvement the texture and sensory properties by increasing total solids constituents of fermented camel milk, by the addition of milk powder **(Mortada** and **Omer, 2013)** and stabilizers such as gelatin, guar gum and sodium carboxymethyl cellulose **(Ibrahim** and **Khalifa, 2015)**. In addition whey protein polymers/isolates are also used as gelling agents in stirred camel yoghurt **(Sakandar et al., 2014)**.

Camel's milk is considered a healthy food and incorporating dietary fiber will make it even healthier. Currently, several studies have linked certain dietary fibers with many positive health effects relating to health promotion and disease prevention such as the maintenance of gastrointestinal health, protection against colon cancer, lowering of total and low density lipoprotein cholesterol in the blood serum, reduction of postprandial blood glucose levels, increase of calcium bioavailability **(Elleuch et al., 2011** and **Soukoulis et al., 2009)**. Therefore, consuming symbiotic foods that contain prebiotics (fibers) and probiotics (lactic acid bacteria) would offer added nutritional benefits that can help boost overall health and well-being **(Ndife et al., 2014)**.

Date and citrus fibers have better quality than other dietary fibers due to the presence of associated bioactive compounds, such as flavonoids, polyphenols and carotenes **(Elleuch et al., 2008**, **Fernández-Gines et al., 2003** and **Hashim et al., 2009)**.

Dietary fibers can provide a multitude of functional properties when they are incorporated in food systems. Thus, fibers addition contributes to the modification and improvement of the texture, sensory characteristics and shelf-life of foods due to their water- binding capacity, gel-forming ability, fat mimetic, antisticking, anticlumping, texturising and thickening effects **(Abdul-Hamid** and **Siew Luan, 2000** and **Wang et al., 2002)**.

Formulation of new food products with ingredients from fruit by-products rich in total dietary fibers has increased in recent years. In some of these studies, dietary fibers such as oat, rice, soy, and maize fibers **(Fernández-García** and **McGregor, 1997)** apple, wheat or bamboo fibers **(Staffolo et al., 2004)** and **(Seçkin** and **Baladura, 2012)** lemon and orange fibers **(Sendra et al., 2010)** and date fiber **(Hashim et al., 2009)** used for enriching yoghurt.

Residues from orange juice extraction are potentially an excellent source of dietary fibers because this material is rich in pectin and may be available in large quantities **(Grigelmo-Miguel** and **Martin-Belloso,1998)**. **García-Pérez et al., (2005)** reported that yoghurt containing 1% orange fiber had a lighter, more red and more yellow color [lower lightness (L*), higher redness (a*) and yellowness (b*) values] in addition to having lower syneresis than control and yoghurt containing 0.6 and 0.8% orange fiber. Moreover, fermented milk enriched with citrus fiber (orange and lemon) had good acceptability **(Sendra et al., 2008)**.

Date fiber is a by-product remained after date syrup extraction and used mainly as animals feed in Egypt. **Hashim et al.,(2009)** reported that, yoghurt fortified with up to 3% date fiber had similar sourness, sweetness, firmness, smoothness, and overall acceptance ratings as the control yoghurt.

The possibility of successfully including orange and date fiber by-products in dairy products would help in enhancing health-promoting effects of dietary fiber and camel milk. Therefore, the objective of this study was to evaluate the effect of the addition of date and orange dietary fibers on physiochemical properties, colour parameters and sensory evaluation of camel's yoghurts during 21d of storage period at (4 ±1°C).

2. Materials And Methods:

Ingredients:

Fresh camel's milk were obtained from the herd of Sidi-Barani areas, Matrouh Governorate, North West Coast, Egypt. The gross composition of raw camel milk was: 12.42±0.21 % total solids, 3.24±0.02 % total protein, 3.35±0.07 % fat, 5.00±0.19 % lactose, 0.18±0.01 % titratable acidity and 6.65±0.03 pH . Commercial stabilizer (gelatin E441 and mono and diglyceride of fatty acid E471 (1:1) was obtained from EGY DAIRY (10th of Ramadan City, Egypt).

Fiber concentrates:

Orange fiber was obtained from juice extraction of Valencia orange (*C. sinensis*) by-products by a procedure described by **(Fernández-López et al., 2004)**. The resultant fibers were grounded and screened to obtain a powder particle size of less than 0.417 mm. Date fiber was obtained from Sewi date (*Phoenix dactylifera L.*) processing by-product, date syrup (dibs) production plant. After removing the seeds, the date by-product was rinsed with water, dried for 24 h at 40 ºC, milled and preserved at 20 ºC prior to extraction according to the method described by **(Elleuch et al., 2008)**. Fiber extracts were dried at 100°C in the oven; then milled and screened to obtain a powder particle size of less than 0.531 mm.

Microbial cultures:

Direct vat culture of commercial lyophilized FD-DVS ABT-3, containing (*Lactobacillus acidophilus* LA-5, *Bifidobacterium animalis subsp. lactis BB-12*, and *Streptococcus salivarius subsp. thermophilus*) were supplied by Chr-Hansen company (Horsholm, Denmark) were used for inoculation fermented camel's milk.

Yoghurt Making:

Camel's milk yoghurt was manufactured according to the method reported by **Tamime** and **Robinson, (1999)**. Yoghurt was made by dissolving stabilizer (0.6%) in whole camel's milk (to prevent the sedimentation of the fibers). The fibers of date and orange was added according to the composition of the samples at ratio (0, 1.5, 3.0, and 4.5%). The mixture was heated in a water bath at 85°C for 30 min, cooled to approximately 42°C, inoculated with commercial yoghurt culture FD-DVS ABT-3, containing (*Lactobacillus acidophilus* LA-5, *Bifidobacterium animalis subsp. lactis BB-12*, and *Streptococcus salivarius subsp. thermophilus*) supplied by Chr-Hansen company (Horsholm, Denmark). The lyophilized culture ABT-3 culture was suspended in 10% reconstituted skim milk powder, autoclaved at

110°C for 10 min, and used to inoculate the milk samples at the rate of 0.2 U/L corresponding to 2.0 % (vol/vol) conventional bulk starter as recommended by the manufacturer. The inoculated milks were poured into 150 g plastic cups with lids and incubated at 42°C for 6 h. After fermentation, yoghurt samples were cooled down and transferred to a refrigerator at 4±1°C, then stored at this temperature over 21 d for analyses. The experiment was replicated 3 times on different days.

Chemical Analysis:

Dried date and orange fibers:

Dried date and orange fibers was analyzed for moisture, ash, crude protein and crude fat contents according to the American Association of Cereal Chemists **(AACC, 2001)** .Total carbohydrates were determined with the Dubois method **Chaplin and Kennedy, (1986)**. Results were expressed in grams per 100 g of dry matter (DM). Total dietary fiber (TDF), soluble (SDF) and insoluble (IDF) dietary fiber contents were estimated according to method of **Prosky, et al., (1988)**.Water-holding capacity (WHC) was determined using the method described by **MacConnell et al., (1974)**. Oil-holding capacity (OHC) was measured using a method described by **Caprez, et al., (1986)**.

Yoghurt analyses:

The pH of the samples was determined using a digital pH meter (model pH 211; Hanna Instruments). Titratable acidity, expressed as percentage of lactic acid was measured using the methods of **(AOAC, 2005)**. Analyses were performed in triplicate after storing the product for 1, 7, 14 and 21 days at 4±1°C.

Determination of colour:

The color parameters L*, a*, and b* values were measured by using CIELAB color space hunter lab (Color Flex; Hunter Lab, Reston, VA, USA). In this coordinate system, the L* value is a measure of lightness, ranging from 0 (black) to 100 (white); the a* value ranges from -100 (greenness) to +100 (redness) and the b* value ranges from -100 (blueness) to +100 (yellowness). For the measure of fiber color, the fiber was rehydrated with water for 1 hour.

Rheological measurements:

Apparent viscosity (mPa.s):

The apparent viscosities were determined according to **Donkor et al.,(2007)** with slight modifications. A Brookfield DVII+ viscometer (Brookfield Engineering Lab Inc., Stoughton, Mass., U.S.A.) was used to determine the apparent viscosities on yoghurts at 10°C after 1, 7, 14 and 21 days of storage . The spindle used (no.4 spindle at 10 rpm) in 150 g of yoghurt. The spindle was allowed to rotate in the sample for 60 s of shearing. The apparent viscosity reading in millipascal second (mPa.s) was noted from the digital output of the viscometer. The measurements were performed in triplicate for each sample.

Gel firmness:

The firmness of yoghurt samples was measured by using a texture analyzer (TA-XT2 model, Stable Micro Systems, Godalming, Surrey, U.K.) using a single compression cycle test with a 5-kg load cell. The probe used was a 35mm diameter aluminum cylinder. Pretest and test speed were fixed at 1 mm/s and penetration depth was 3.0 cm **(Sandoval-Castilla et al., 2004)**. The firmness of yoghurt samples was expressed in gram. The measurements were done in triplicate.

Syneresis index:

Syneresis can be defined as the spontaneous water release from a gel due to gel shrinkage. The released whey in the yoghurt samples was measured according to **(Tsevdou et al., 2013)** by inverting a 100-g sample on a Buchner funnel lined with a Whatman filter paper number #1(Whatman International Ltd., Maidstone, England). The quantity of whey collected in a graduated cylinder after 3h of drainage at 8 ºC was used as an index of syneresis. Syneresis was determined on 3 cups of yoghurt per replication.

Microbiological analyses:

Bacterial counts of each treatment were carried out in triplicate after 1, 7,14 and 21 days. Aliquots (1.0 g) of each sample were diluted with 9 mL of 1 g/L sterile peptonated water. After serial dilutions, bacteria were counted by the pour plate technique. Counts of *S. thermophilus* were enumerated on M17 agar containing 5g/L lactose (Oxoid Ltd., Basingstoke, UK) **Torriani et al., (1996)**. The pH of the medium was 6.9 ± 0.1. The inoculated plates were incubated aerobically at 37° C for 48 h. Enumeration of *Lb. acidophilus* was on MRS agar (Oxoid Ltd., Basingstoke, UK) supplemented with 0.5g L 1cysteine, (Merck, Germany), and anaerobical conditions incubation at 37°C for 72 h **(Lankaputhra et al., 1996)**. Enumeration of *Bifidobacterium animalis subsp. lactis* was determined according to **Lankaputhra et al., (1996)** using MRS-NNLP (nalidixic acid, neomycine sulfate, lithium chloride, paromycine sulfate) and vancomycine (Sigma Chemical Co., St Louis, MO) agar. Plates were incubated for 48 h at 37°C in anaerobic conditions. Enterobacterial group count was enumerated by plating suitable dilution on violet red bile agar medium (V.R.B.A) (Oxoid Ltd., Basingstoke, UK) as described by American Public Health Association **(APHA, 1992).** The plates were incubated for 24 h at 35±1°C. Oxytetracycline-glucose-yeast extract agar (OGYE AGAR) medium as described by American Public Health Association **(APHA,1992)** was used in counting Moulds and Yeasts (Oxoid Ltd., Basingstoke, UK). Plates were incubated at 25±1°C for 4-5 days. Plates containing 30-300 colonies were enumerated and recorded as colony forming units (CFU) per gram of sample.

Sensory evaluation:

Ten panelists from the staff members at Desert Research Center (DRC), Egypt were selected on the bases of their training and experience in the use and evaluation of control and yoghurt prepared with 1.5, 3 and 4.5 % dried date and orange fibers. Yoghurt samples were organoleptically examined according to the scheme described by **(Farag et al., 2007)**. They evaluated 20 g portions of each yoghurt sample and used a quality rating score card for evaluation of flavour (45 points), body and texture (35 points), appearance and color (10 points) and acidity (10 points). Panelists evaluated all yoghurt samples after storage for 1, 7, 14 and 21 days.

Statistical analysis:

Data analysis was conducted using **SPSS (2012)** Statistical Software (version 18.0, SPSS Inc., Chicago, IL, USA) as factorial arrangement, analysis of variance (ANOVA) was applied, and Duncan's multiple range test. Standard error of the means was derived from the error mean square term of the ANOVA, which was used the least significant difference (LSD) test. Differences were considered significant at ($P<0.05$).

3. Results and Discussion:

The chemical composition of date and orange fibers was presented in Table 1. The results showed that, the date fiber contained higher total dietary fiber 88.57±2.25 %, crude protein 10.33±0.58 % and lower crude fat 1.87±0.21%, similar values reported by **Elleuch et al., (2008)** and **Bravo** and **Saura-Calixto, (1998)** for date and orange fibers. Furthermore, the orange fiber had higher levels of soluble dietary fiber 19.70±0.69 %, and lower IDF/SDF ratio 2.38:1. This finding is in agreement with that obtained by **(Crizel et al., 2013** and **Fernández-López et al., 2009)**. However, the different between tow dietary fibers attributed to these different proportions of cellulose, pectin, hemicelluse and lignin in date and orange fibers, and the different crosslinking forms of polysaccharide on the intermolecular level both lead to the different physicochemical properties **(Crizel et al., 2013)**.

On the other hand, the highest values of water holding capacity 13.73±0.32 mL water/g were found in orange fiber. These values was similar to those found by **Fernández-López et al., (2009)** for orange byproduct dietary fiber. However, the soluble–insoluble ratio is important for both dietary/functional properties derived from dietary fiber. According to **Figuerola et al., (2005)**, fibers that have high hydration capacity can be used as a functional food ingredient to reduce calories, to avoid syneresis, and to modify the viscosity and texture of the final product.

Oil holding capacity (OHC) is another functional property of some ingredients used in formulated food. In general, the highest values of oil holding capacity 7.67±0.06 g/g were found in date fiber. These OHC values are comparable with reported data for date fibers by **Elleuch et al., (2008).** The higher OHC of date fiber indicated that it could be used as an ingredient to stabilize foods with a high percentage of fat and emulsions **(Elleuch et al., 2008)**. According to **Thebaudin et al., (1997)**, the source of the fiber and its particle size can affect the oil holding capacity, and insoluble fiber can hold up to five times its weight in oil.

On the other hand, the color analysis showed that orange fiber had the highest L* (75.43±1.16) and b* (20.33±0.68) values while the date fiber had the highest value of a* (3.37±0.06) . A similar result was obtained by **Crizel et al., (2013)** and **Elleuch et al., (2008)** for orange and date fibers.

Table 1. Physical and chemical properties of date and orange dietary fibers by-products used in study (g/100 g dry matter).

Proximal composition	Date fiber	Orange fiber
Moisture	8.09±0.54	7.83±0.37
Crude protein	10.33±0.58	7.43±0.10
Crude fat	1.87±0.21	3.23±0.15
Ash	2.77±0.02	2.58±0.16
Total carbohydrates	67.41±1.79	82.47±2.47
Total dietary fiber (TDF)	88.57±2.25	65.43±0.65
Insoluble dietary fiber (IDF)	80.20±1.01	46.73±1.01
Soluble dietary fiber (SDF)	7.47±0.55	19.70±0.69
IDF/SDF	10.78±0.74	2.38±0.13
Functional properties of samples		
(WHC[*1])	9.13±0.85	13.73±0.32
(OHC[*2])	7.67±0.06	3.57±0.68
Color	Beige brown	White
Flavor and odor	Neutral	Fruity
L* (lightness)	13.47±1.16	75.43±1.16
a* (red/greenness)	3.37±0.06	2.73±0.06
b* (yellow/blueness)	7.47±0.12	20.33±0.68

[*1]Water holding capacity (mL water/g powder),[*2]Oil holding capacity (g oil/g powder)

pH and Acidity:

Table 2. shows the changes in pH and titratable acidity % values of control and yoghurt fortified with date or orange fiber samples during storage period at (4 ±1°C). In general, the pH values of all yoghurt samples decreased slightly during storage, and this was found to be statistically significant ($P<0.05$). At the end of 21 days, control sample had the highest pH of 4.65±0.06, while yoghurt enriched with 4.5% orange fiber had lowest values of pH 4.53±0.10 .

These results were consistent with previous study in orange fiber fortified yoghurt, in which about 0.2 unit of pH reduction was observed after one week of storage **(García-Pérez et al., 2005)**. The decrease of pH during the storage can be attributed to the high bacterial metabolic activity with the consumption of lactose and lactic acid production **(Bakirci** and **Kavaz, 2008)** . **Shah, (2000)** observed similar decreases in pH values during storage of commercial yoghurts containing *L. acidophilus* and *B. bifidum* without any effect on cell counts. Also, the decrease of pH during the storage can be explained by the low pH (4.0) of the orange fiber that acidifies the product where it is added **(García-Pérez et al., 2005)**.

On the other hand, the titratable acidity % of all yoghurts showed an opposite trend to pH values. Titratable acidity % of the all yoghurt samples was affected by different ratios addition of orange and date fibers, and a gradual increase ($P<0.05$) in titratable acidity % was noted for all yoghurt samples during storage with significant ($P<0.05$) different among treatments. Yoghurt enriched with 4.5% orange fiber had higher acidity 1.28±0.01% while date and control yoghurt had the lowest value of 1.11±0.03 %, respectively. According to **Fernández-García** and **McGregor (1997)**, some fibers may provide nutrients, or factors that stimulate the starter culture, which promotes higher acidity. The ability of some fibers to increase the acidity of fermented products has also been described using the orange, soy, rice, maize, oats and sugar beet fibers **(García-Pérez et al., 2006** and **Lario et al., 2004)**. This is a positive feature, as it indicates that some fibers may stimulate the metabolism of starter culture.

Colour parameters:

The changes in color parameters of control and yoghurt fortified with date or orange fibers stored at 4 ±1°C during 21days are presented in Table 2. Generally, for all yoghurt tested samples, color parameters (L*, b* and a*) values was affected by the fiber levels and source type. On the other hand, the storage time had significantly effected ($P<0.05$) on L* values, but b* and a* values not influenced ($P<0.05$) by the storage time.

The L*, b* and a* values of the experimental yoghurts increased up in the first 14 days followed by a decrease at the end of the storage. However, the L* values of yoghurt fortified with 4.5 % date fiber was lower than that of yoghurt fortified with orange fiber ($P<0.05$). **Hashim et al.,(2009)** reported that yoghurts fortified with date fiber had darker color (lower L* and higher a*) compared with control or wheat bran yoghurts. Therefore, date fiber presented a darkening effect and a decrease in whiteness is expected.On the other hand, after orange and date fiber adding, a* values of all samples fortified were negative. The highest ($P<0.05$) negative a* value was observed in yoghurts fortified with 4.5% date fiber. Similar results were reported for yoghurts fortified with date fiber **(Hashim et al., 2009)** and orange fiber **(García-Pérez et al., 2005)**.

Furthermore, the fortification types and level of fibers had a significant effect ($P<0.05$) on the yoghurt b* value. However, yoghurts fortified with 4.5% orange fiber had significantly ($P<0.05$) higher b*values compared with the control and date fiber yoghurt during storage. **García-Pérez et al.,(2005)** reported that when orange fiber percentage was increased in yoghurts, an increase of b* values (more yellowness) and a decrease in L* values (less whiteness) were observed. Thus increasing of the fiber addition resulted in reduced L* and increased b* values. Similar results were reported by **(Hashim et al., 2009)** for yoghurts fortified with date fiber and orange fiber by **García-Pérez et al., (2005)**.

In general, yoghurt fortified with date fiber had a brownish color, whereas yoghurt fortified with orange fiber had a yellowish color. **Staffolo et al.,(2004)** reported that fortification with commercial wheat, bamboo, or inulin fibers had no effect on yoghurt color. This indicated that yoghurt color is dependent on the color of the fiber source.

Rheological properties:

Apparent viscosity:

The mean values of the viscosity of both control and yoghurt fortified with date or orange fiber samples significantly ($P<0.05$) dependent on the storage period. Generally, the viscosity values of the experimental yoghurts increased up in the first 14 days followed by a decrease at the end of the storage period Table 3. According to **Lee** and **Lucey, (2010)** and **Sahan et al., (2008)** the increase in viscosity values for nonfat yoghurt during 15 d of storage can be associated with the rearrangement of protein molecules as recovery of structure or rebodying. Similarly, **Akalin et al., (2008)** observed fluctuations in the viscosity values of their samples during storage.

Furthermore, the viscosity values of all yoghurt samples was also significantly influenced ($P<0.05$) by the fortification type and level of the dietary fiber. According to the results, the highest viscosity values were found in the yoghurt fortified with 4.5% orange fiber while, the control was least viscous with significant difference ($P<0.05$) between all types of yoghurt. Fibers with high hydration capacity can increase the viscosity of the food to which they are added **(Crizel et al., 2013** and **Taha et al., 2011)**. **Sendra et al. (2010)** fortified yoghurt with orange fiber and showed increased viscosity and improved water absorption.

On the other hand, residues from orange juice extraction are potentially an excellent source of dietary fibers because this material is rich in pectin and may be available in large quantities **(Grigelmo-Miguel** and **Martın-Belloso, 1998)**.The significant content of soluble matter in pectin, which is well known for its gel-forming ability **(Luz Fernandez, 2001)**, can explain the intense enhancement of viscosity, than the yoghurt fortified with date fiber. Thus, orange fiber can be considered as a suitable food ingredient for when hydration-related properties are required.

Table 2. Changes in pH, titratable acidity % and colour parameters (means*±SD) of control and yoghurt fortified with date or orange fibers during storage period at (4 ±1°C).

Treatment	Storage (Day)	Control	Date fiber 1.5%	3%	4.5%	Orange fiber 1.5%	3%	4.5%	Main effects
pH	1	4.90±0.10	4.82±0.03	4.80±0.10	4.78±0.06	4.73±0.06	4.68±0.03	4.63±0.12	**4.76^{a}±0.11**
	7	4.83±0.06	4.77±0.03	4.77±0.15	4.69±0.03	4.65±0.10	4.67±0.15	4.57±0.05	**4.71^{ab}±0.12**
	14	4.70±0.10	4.68±0.04	4.77±0.06	4.63±0.06	4.61±0.06	4.63±0.12	4.53±0.06	**4.65^{bc}±0.09**
	21	4.65±0.06	4.64±0.07	4.63±0.06	4.60±0.00	4.54±0.05	4.60±0.10	4.53±0.10	**4.60^{c}±0.07**
	Main effects	**4.77^{a}±0.13**	**4.73^{abc}±0.08**	**4.74^{ab}±0.11**	**4.68^{bcd}±0.08**	**4.63^{de}±0.09**	**4.65^{cde}±0.10**	**4.57^{e}±0.09**	
Titratable acidity%	1	0.77±0.02	0.77±0.02	0.80±0.01	0.85±0.01	0.81±0.01	0.83±0.03	0.88±0.01	**0.82^{d}±0.04**
	7	0.84±0.03	0.85±0.02	0.85±0.02	0.92±0.03	0.92±0.02	0.87±0.03	0.94±0.02	**0.88^{c}±0.04**
	14	0.87±0.02	0.87±0.03	0.89±0.02	1.06±0.05	0.95±0.01	0.93±0.03	1.17±0.05	**0.96^{b}±0.11**
	21	1.11±0.03	1.18±0.03	1.11±0.01	1.15±0.05	1.22±0.03	1.22±0.03	1.28±0.01	**1.18^{a}±0.07**
	Main effects	**0.90^{b}±0.14**	**0.92^{b}±0.17**	**0.91^{b}±0.12**	**0.99^{ab}±0.13**	**0.98^{a}±0.16**	**0.96^{ab}±0.16**	**1.07^{a}±0.17**	
L* values (lightness)	1	98.13±0.55	81.87±0.74	76.27±0.97	71.07±1.27	88.27±0.68	79.70±0.35	76.67±0.59	**81.71^{b}±8.56**
	7	98.37±0.74	86.87±0.57	79.07±0.23	65.97±0.21	91.30±1.15	83.53±0.75	81.17±1.31	**83.75^{b}±9.71**
	14	98.43±0.50	92.20±1.40	86.10±0.61	81.80±0.53	94.43±0.95	87.23±0.70	92.03±1.89	**90.32^{a}±5.40**
	21	97.03±0.76	86.37±0.15	77.43±1.29	74.03±0.40	89.60±0.56	84.63±0.45	81.87±0.46	**84.42^{b}±7.30**
	Main effects	**97.99^{a}±0.81**	**86.83^{b}±3.89**	**79.72^{e}±4.06**	**73.22^{f}±6.02**	**90.90^{ab}±2.52**	**83.78^{cd}±2.87**	**82.93^{de}±5.96**	
a*(-) values (red/greenness)	1	1.02±0.08	3.15±0.26	4.23±0.09	6.14±0.21	1.24±0.02	0.88±0.06	0.65±0.15	**2.47^{a}±2.00**
	7	1.12±0.02	3.56±0.06	5.18±0.04	7.84±0.11	1.57±0.12	0.96±0.01	0.79±0.04	**3.00^{a}±2.54**
	14	1.13±0.01	3.66±0.06	6.31±0.35	8.42±0.26	1.89±0.06	1.30±0.05	0.97±0.03	**3.38^{a}±2.78**
	21	1.16±0.06	3.39±0.14	5.02±0.09	7.65±0.25	1.57±0.10	1.16±0.08	0.88±0.01	**2.98^{a}±2.43**
	Main effects	**1.11^{e}±0.07**	**3.44^{c}±0.24**	**5.18^{b}±0.79**	**7.51^{a}±0.90**	**1.57^{d}±0.25**	**1.08^{e}±0.18**	**0.82^{e}±0.14**	
b* values (yellow/blueness)	1	7.74±0.09	11.13±0.74	11.75±0.20	12.47±0.51	16.54±0.25	20.48±0.55	23.32±0.35	**14.78^{a}±5.29**
	7	7.87±0.21	12.75±0.20	14.10±0.37	14.03±0.13	18.00±0.19	24.07±0.55	26.18±0.67	**16.71^{a}±6.17**
	14	8.03±0.12	13.46±0.15	16.18±0.56	16.35±0.20	19.56±0.30	26.13±0.49	28.63±0.08	**18.33^{a}±6.79**
	21	7.87±0.06	12.33±0.18	14.45±0.18	15.15±0.31	17.98±0.13	23.69±0.38	25.25±0.54	**16.67^{a}±5.86**
	Main effects	**7.88^{f}±0.15**	**12.42^{e}±0.95**	**14.12^{d}±1.68**	**14.50^{d}±1.52**	**18.02^{c}±1.13**	**23.59^{b}±2.16**	**25.84^{a}±2.03**	

*Means are calculated from three replicate samples.

[abcd..] Means in the same column and row with different letters differ significantly at (P< 0.05).

In our study, the use of date fiber**s** in camel's yoghurt formulations significantly increased the viscosity of the yoghurt product. However, yoghurt fortified with 4.5% date fiber had also shown a higher viscosity than control yoghurt. This improvement in product viscosity is likely to be related to increased water holding capacity in the formulations. The addition of different fiber sources, such as bamboo, apples, wheat, or inulin fibers, affects the viscosity in yoghurt **(Staffolo et al., 2004).**

Gel firmness:

Generally, the storage time affected ($P<0.05$) on firmness values of all tested samples. The firmness values of the experimental yoghurts slightly increased up in the first 14 days followed by a decrease at the end of the storage period (Table 3). This situation may be attributed to increased water holding capacity of dietary fibers with time storage. Increasing the firmness may be related to dietary fibers absorbing more moisture because of its higher water-holding capacity **(Hashim et al., 2009)**.

However, the fortification types and level of fibers had a significant effect ($P<0.05$) on the yoghurt firmness. Firmness values of yoghurt fortified with 4.5% orange fiber were significantly ($P<0.05$) higher than control or date yoghurt during the storage period. **Staffolo et al., (2004)** and **Sendra et al., (2010)** reported increased firmness and viscosity in fermented milk products with the addition of different fibers. **Coggins et al. (2010)** observed that an increase in the viscosity, firmness and a reduction in syneresis might be due to pH reduction during the storage of the fermented products, allowing for gel contraction.

The incorporation of either orange or date fibers in yoghurt formulation resulted in an increase in product firmness in comparison with the control samples. The texture results along with the rheological results are in agreement with the trends observed for yoghurts syneresis; increased firmness would make yoghurt less susceptible to shrinkage and serum (whey) expulsion.

Table 3. Rheological properties (mean* ±SD): viscosity (mPa), gel firmness (g) and syneresis (100 ml) of the experimental control and yoghurt fortified with date or orange fibers during storage period at (4 ±1°C).

Treatment	Storage (Day)	Control	Date fiber			Orange fiber			Main effects
			1.5%	3%	4.5%	1.5%	3%	4.5%	
Viscosity	1	16.54±0.70	16.00±0.56	20.63±0.87	23.63±0.40	20.14±0.87	27.17±0.31	32.17±0.87	**22.33^{b}±5.55**
	7	17.21±1.18	18.20±2.01	22.13±0.25	27.33±0.51	22.25±0.27	30.83±1.10	36.17±0.83	**24.88^{ab}±6.62**
	14	18.59±0.69	19.20±0.85	25.43±1.08	29.77±0.64	23.26±1.25	32.97±1.01	38.90±1.37	**26.87^{a}±7.12**
	21	17.51±1.66	18.25±1.05	22.37±1.03	28.97±1.29	22.45±0.66	30.60±1.80	37.93±1.12	**25.44^{ab}±7.10**
	Main effects	**17.46^{f}±1.24**	**17.91^{e}±1.62**	**22.64^{d}±1.97**	**27.43^{c}±2.55**	**22.03^{d}±1.40**	**30.39^{b}±2.39**	**36.29^{a}±2.84**	
Gel firmness	1	22.90±1.31	26.43±0.31	29.37±0.81	34.83±0.25	33.63±0.98	40.70±0.35	41.63±0.51	**32.79^{b}±6.69**
	7	24.27±0.21	28.97±0.40	32.53±0.51	39.03±0.76	35.90±0.50	40.70±0.72	45.97±0.21	**35.34^{ab}±7.01**
	14	28.63±1.10	32.83±0.58	35.57±0.72	44.37±0.81	39.30±0.26	45.10±0.78	50.37±1.27	**39.45^{a}±7.29**
	21	27.60±0.50	31.20±1.15	33.83±0.64	42.50±1.00	36.47±1.35	42.90±1.39	48.63±1.03	**37.59^{a}±7.09**
	Main effects	**25.85^{f}±2.57**	**29.86^{e}±2.58**	**32.83^{d}±2.44**	**40.18^{b}±3.85**	**36.33^{c}±2.24**	**42.35^{b}±2.05**	**46.65^{a}±3.52**	
Syneresis	1	32.37±0.81	29.03±0.74	26.43±1.17	23.17±0.06	25.73±0.29	21.00±0.52	18.67±0.38	**25.20^{a}±4.49**
	7	29.13±0.64	27.83±1.05	24.07±0.45	20.20±0.85	23.23±0.29	19.67±0.21	17.83±0.06	**23.14^{ab}±4.05**
	14	27.63±0.81	26.20±0.36	23.30±0.62	19.20±0.62	21.03±0.72	18.73±1.24	17.27±0.21	**21.91^{b}±3.78**
	21	26.07±0.76	24.67±0.51	21.60±0.10	19.07±0.29	20.37±1.03	17.80±0.79	16.63±0.51	**20.89^{b}±3.35**
	Main effects	**28.80^{a}±2.51**	**26.93^{b}±1.83**	**23.85^{c}±1.91**	**20.41^{d}±1.79**	**22.59^{c}±2.27**	**19.30^{d}±1.41**	**17.60^{e}±0.83**	

*Each value represents the mean of three replicates.
abcd.. Means in the same column and row with different letters differ significantly at (P< 0.05).

Whey Syneresis:

In general, storage time significantly (*P<0.05*) affected on syneresis values. The means of syneresis values decreased gradually for all yoghurt samples with increasing storage period (Table 3). The presence of fiber reduced the syneresis, but syneresis became evident with the storage.

With regard to the effect of the fiber type and the addition rate on the whey syneresis of yoghurts were found statistically significant (*P<0.05*).The highest mean value (26.07 mL/100 g) of syneresis was found in control samples and the lowest mean value (16.63 mL/100 g) in yoghurt fortified with 4.5 % orange fiber at the end of storage period. This could be explained by the availability of orange fiber from, which has high water-holding capacity, swelling and gel forming **(García-Pérez et al., 2005)**. **García-Pérez et al., (2006)** observed that fiber concentration modified yoghurt rheology and the addition of 1g/100 ml orange fiber reduced syneresis when compared to control samples, because of the high water holding capacity of the orange fiber that absorbs the whey released by the gel structure.

Viable counts of starter cultures:

The changes in the viable counts of starter cultures, enterobacterial groups and yeasts & moulds of control and fortified yoghurts with dare or orange fibers during refrigerated storage are presented in Table 4.

The counts of S. *thermophilus* showed a maximum increment during the 7 days and then declined slightly in all yoghurts until the end of storage period and the differences between the days of storage were significant (*P<0.05*) (Table 4). **Oliveira et al., (2009)** reported similar results for counts of *S. thermophilus* in fermented lactic beverages containing probiotic bacteria. Also, **Espírito Santo et al., (2010)**, observed higher counts of *S. thermophilus* in yoghurts co-fermented by *L. acidophilus* L10 and *B. animalis subsp. Lactis* B94, reinforce the positive correlation between *S. thermophilus* and these two probiotic strains.

Furthermore, the fortification level of fibers had a significant effect (*P<0.05*) on the viable counts of *S. thermophilus* between all yoghurt samples. In general, the highest viable counts of *S. thermophilus* were enumerated in yoghurt fortified with 4.5% orange fiber. This is in agreement with the faster reduction of pH observed during fermentation (Table 2). Enhance growth of S. *thermophilus* may be due to the availability of some nutrients as soluble fructooligosaccharides in orange fibers **(Sendra et al., 2008)**.

On the other hand, the highest viability of *Lb. acidophilus* and *B. lactis* noticed during 14 days of storage in all yoghurts then decline throughout storage period with significant difference (*P<0.05*) between all types of yoghurt (Table 4). This result was in agreement with previous study that found refrigerated storage decreased the viable counts of probiotic bacteria significantly by the 14th day of refrigerated storage **(Kailasapathy et al., 2008** and **Laniewska-Trokenheim et al., 2010)**. Additionally, **Rybka and Kailasapathy, (1995)** demonstrated that *L. acidophilus* could survive in yoghurt at sufficient levels ($\geq 10^6$ cfu/mL^{-1}) for up to 28 days. Also, **Lankaputhra** and **Shah, (1995)** and **Shah** and **Jelen, (1990)** reported that *L. acidophilus* survived better than the traditional yoghurt culture organisms (*L. delbrueckii subsp. bulgaricus and S. thermophilus*) in yoghurt under acidic conditions *and L. acidophilus* was also more tolerant of acidic conditions than *B. bifidum*.

Generally, the highest viable counts of *Lb. acidophilus* and *B. lactis* were enumerated in yoghurts fortified with 4.5% orange fibers, whereas control and yoghurts supplemented with date fiber had the lowest values with significant difference (*P<0.05*) between all yoghurts.

Table 4. Changes in the viable counts (mean[*] ±SD) of starter cultures, enterobacterial groups and yeasts & moulds (CFU/mL^{-1}) of control and fortified yoghurts with dare or orange fibers during storage period at (4±1°C).

Treatment	Storage (Day)	Control	Date fiber			Orange fiber			Main effects
			1.5%	3%	4.5%	1.5%	3%	4.5%	
Streptococcus thermophilus	**1**	6.29±0.51	6.62±0.57	6.99±0.57	7.09±0.46	6.74±0.20	7.32±0.59	7.57±0.01	**6.94^{b}±0.57**
	7	6.68±0.15	6.90±0.07	7.19±0.55	7.27±0.64	7.44±0.53	7.63±0.57	7.85±0.57	**7.28^{a}±0.56**
	14	6.14±0.50	6.34±0.32	6.63±0.12	6.86±0.06	6.69±0.14	6.88±0.09	7.36±0.49	**6.70^{bc}±0.45**
	21	5.99±0.46	6.24±0.57	6.58±0.10	6.51±0.51	6.59±0.12	6.75±0.22	7.06±0.66	**6.53^{c}±0.49**
	Main effects	**6.28^{d}±0.45**	**6.53^{cd}±0.6**	**6.85^{bc}±0.43**	**6.93^{bc}±0.50**	**6.86^{bc}±0.44**	**7.15^{ab}±0.52**	**7.46^{a}±0.52**	
Lactobacillus acidophilus	**1**	6.30±0.51	6.40±0.75	6.38±0.36	6.42±0.39	6.52±0.48	6.65±0.57	6.71±0.16	**6.48^{b}±0.43**
	7	6.35±0.48	6.46±0.47	6.40±0.38	6.62±0.92	6.67±0.09	6.78±0.13	6.94±0.51	**6.60^{ab}±0.46**
	14	6.41±0.65	6.53±0.05	6.68±0.13	6.75±0.19	7.07±0.36	7.18±0.60	7.24±0.61	**6.84^{a}±0.48**
	21	6.26±0.39	6.39±0.78	6.50±0.02	6.49±0.49	6.52±0.48	6.75±0.12	6.91±0.03	**6.55^{b}±0.41**
	Main effects	**6.33^{c}±0.44**	**6.45^{c}±0.51**	**6.49^{bc}±0.26**	**6.57^{bc}±0.50**	**6.69^{bc}±0.40**	**6.84^{ab}±0.42**	**6.95^{a}±0.40**	
Bifidobacterium animalis subsp. lactis	**1**	6.17±0.57	6.20±0.63	6.31±0.43	6.33±0.47	6.29±0.70	6.45±0.47	6.53±0.48	**6.33^{b}±0.4 7**
	7	6.32±0.46	6.27±0.41	6.44±0.50	6.29±0.66	6.47±0.61	6.63±0.14	6.63±0.58	**6.44^{b}±0.45**
	14	6.51±0.03	6.59±0.12	6.41±0.42	6.66±0.21	6.81±0.04	6.76±0.15	7.13±0.40	**6.70^{a}±0.30**
	21	6.33±0.37	6.41±0.38	6.36±0.41	6.58±0.04	6.61±0.07	6.68±0.25	6.72±0.14	**6.53^{ab}±0.28**
	Main effects	**6.33^{b}±0.37**	**6.37^{b}±0.40**	**6.38^{b}±0.38**	**6.47^{ab}±0.39**	**6.54^{ab}±0.44**	**6.63^{ab}±0.27**	**6.75^{a}±0.44**	
Enterobacterial groups	**1**	nd	nd	nd	nd	nd	nd	nd	
	7	nd	nd	nd	nd	nd	nd	nd	
	14	nd	nd	nd	nd	nd	nd	nd	
	21	nd	nd	nd	nd	nd	nd	nd	
	Main effects								
Yeast and Moulds	**1**	nd	nd	nd	nd	nd	nd	nd	
	7	nd	nd	nd	nd	nd	nd	nd	
	14	nd	nd	nd	nd	nd	nd	nd	
	21	nd	nd	nd	nd	nd	nd	nd	
	Main effects								

[*]Means are average from three independent trials; nd = Not Detected

[abcd..] Means in the same column and row with different letters differ significantly at (P< 0.05).

Generally, the highest viable counts of *Lb. acidophilus* and *B. lactis* were enumerated in yoghurts fortified with 4.5% orange fibers, whereas control and yoghurts supplemented with date fiber had the lowest values with significant difference (*P<0.05*) between all yoghurts. **Sendra et al., (2008)** found that the addition of citric fiber in fermented milks enhanced the growth and survival of probiotic bacteria, which on turn probably induced a more rapid transformation of lactose into lactic acid. Based on these observations, one can relate the stimulating effect of orange fiber on probiotics to their high contents of soluble dietary fibers, pectins and fructo-oligosaccharides **(Grigelmo-Miguel** and **Martin-Belloso, 1998** and **Marín, et al., 2007).**

Also, **Donkor et al., (2007)** observed significant increased of all probiotics in yoghurt fortified with apple and banana fibers by no less than 1 Log cfu/mL^{-1} compared to both controls and to passion fruit fiber yoghurts, especially at d 28. Moreover, this results similar to those previously observed with inulin, raftilose, maltodextrin, pectin and mainly with fructo-oligosaccharides on *L. acidophilus* and bifidobacteria **(Oliveira et al., 2009** and **Sendra et al., 2008)**.

On the other hand, the results showed that, coliform bacteria and yeasts & moulds was not detected in all sample treatments either when fresh or during cold storage .The absence of coliform bacteria signifies that the yoghurt samples are free from faecal contamination due the hygienic conditions employed during production **(Osundahunsi et al., 2007** and **Taha et al., 2011)**. Also, it may be due to the role of lactic acid bacteria in preservation of the product which associated with their ability to produce some antimicrobial compounds **(El-Nagar** and **Shenana, 1998** and **Ibrahim et al., 2004**).

Sensory evaluation:

The mean scores of the sensorial attributes (flavour, body & texture, color & appearance, acidity taste and overall acceptability) for control and yoghurt fortified with date or orange fibers during storage period at (4 ±1°C) for 21days given by the panelists presented in Table 5. In general, the addition of date and orange fibers in different proportions significantly affected (*P<0.05*) on the scores of the all sensory parameters. Also, the statistical analysis revealed that, the scores of the all sensory parameters in control and date yoghurt samples were significantly (*P<0.05*) lower than those in yoghurt fortified with orange fiber .

According to the results, the yoghurts fortified with 4.5 % orange fiber had significantly (*P< 0.05*) higher flavor scores than control and date yoghurt samples, that might be due to reflecting a combined natural fruity flavour compounds in orange fiber and higher viability of *L. acidophilus*, which may also produce the good components mainly aroma (acetaldehyde and diacetyl). Acetaldehyde for example is recognized as a major flavour component in yoghurt and the presence of lactobacilli in the starter culture can influence the total content of acetaldehyde in final product **(Guler-Akin** and **Akin, 2007).** Also, **Hashim et al., (2009)** indicated that yoghurt containing a high level of date fiber had a different flavor than control therefore, they flavored the yoghurt with vanilla to mask the flavor that might arise from the high level of addition of date fiber.

However, the mean flavor score of all yoghurt samples decreased significantly (*P<0.05*) with increased storage time. The results are in agreement with the findings of **(Salwa et al., 2003** and **Tarakci and Kucukoner, 2003)** they found a decrease in flavor of yoghurt during storage.

Statistical analysis revealed that the fortification type and level of fibers had a significant effect (*P<0.05*) on body and texture scores. However, the yoghurt fortified with 4.5% orange fiber significantly (*P<0.05*) higher in body and texture scores than control or date yoghurt during storage period. Increasing the body and texture may be related to dietary fiber absorbing more moisture because of its higher water-holding capacity. **Fernández-García et al., (1998)** and **Hashim et al.,(2009)** reported that fiber addition improved the body and texture of unsweetened yoghurt.

Body and texture scores for all yoghurt increased significantly (*P<0.05*) during storage period. These findings are in agreement with those obtained from the analysis of the apparent viscosity of fortified with date and orange fibers (Table 3). Viscosity is a parameter that is directly related to the texture attribute of the sensory analysis, which in turn is a key factor for consumers' choice of a product **(Damin et al., 2009)**.

On the other hand, general comments by the panellists regarding sensory attributes were also evaluated. The most common criticisms were related to the semi-liquid texture of the control and yoghurt fortified with 1% date or orange fibers also non-typical yoghurt taste and flavour.

Colour and appearance of the yoghurt samples was scored most highly for all yoghurt fortified with orange fibers, while among the various preparations addition of 4.5% orange fibers resulted in the highest scores for colour and appearance.

Table 5. Sensory quality and acceptability (mean* ±SD) of control and yoghurt fortified with date and orange fiber during storage period at (4 ±1°C).

Treatment	Storage (Day)	Control	Date fiber			Orange fiber			Main effects
			1.5%	3%	4.5%	1.5%	3%	4.5%	
Flavour (45)	1	36.29±0.76	34.00±1.41	33.29±1.25	32.57±1.13	37.57±0.98	39.43±1.27	41.14±1.07	36.33^{a}±3.22
	7	34.71±0.49	33.29±1.70	32.29±2.21	31.57±1.40	36.14±1.77	38.14±1.07	39.86±0.90	35.14^{ab}±3.19
	14	32.71±0.49	33.00±1.73	31.86±0.69	31.43±0.79	36.00±1.41	37.00±1.83	38.57±0.53	34.37^{bc}±2.84
	21	32.29±1.80	32.43±1.90	31.43±1.40	30.71±0.49	35.71±1.70	36.43±1.90	37.43±1.72	33.78^{c}±2.93
	Main effects	34.00^{d}±1.91	33.18^{e}±1.70	32.21^{f}±1.57	31.57^{f}±1.17	36.36^{c}±1.59	37.75^{b}±1.88	39.25^{a}±1.78	
Body & texture (35)	1	25.43±0.53	24.71±1.80	24.86±1.86	26.00±1.73	26.14±1.07	27.14±1.46	28.00±0.82	26.04^{c}±1.73
	7	25.71±0.49	25.71±0.95	25.86±1.46	27.14±2.04	27.43±0.53	28.57±1.90	29.43±0.79	27.12^{b}±1.84
	14	26.86±1.35	26.86±1.57	26.43±1.13	27.43±2.30	28.43±0.53	29.00±0.82	30.14±0.90	27.88^{ab}±1.79
	21	27.14±1.46	26.43±1.81	26.71±1.25	28.00±1.00	29.43±0.98	30.00±0.82	32.14±0.38	28.55^{a}±2.24
	Main effects	26.29^{e}±1.24	25.93^{e}±1.70	25.96^{e}±1.55	27.14^{d}±1.88	27.86^{c}±1.46	28.68^{b}±1.63	29.93^{a}±1.68	
Color& Appearance (10)	1	6.43±0.53	7.00±0.82	6.43±0.53	6.57±0.98	7.29±0.49	7.57±0.53	7.71±0.49	7.00^{a}±0.79
	7	6.14±0.69	6.71±0.49	6.43±0.53	6.29±0.49	7.14±0.38	7.43±0.53	7.57±0.53	6.78^{ab}±0.74
	14	5.86±0.38	6.43±0.53	6.29±0.49	6.14±0.38	6.86±0.38	7.29±0.49	7.43±0.53	6.65^{bc}±0.69
	21	5.57±0.53	6.29±0.76	6.14±0.38	6.00±0.82	6.71±0.49	6.86±0.38	7.29±0.49	6.41^{c}±0.76
	Main effects	6.00^{e}±0.61	6.61^{c}±0.69	6.32^{cd}±0.48	6.25^{de}±0.70	7.00^{b}±0.47	7.29^{ab}±0.53	7.50^{a}±0.51	
Acidity taste (10)	1	7.43±0.53	7.43±0.53	7.57±0.53	7.43±0.53	7.71±0.49	7.86±0.38	7.86±0.38	7.49^{a}±0.62
	7	7.29±0.49	7.29±0.49	7.43±0.53	7.29±0.49	7.57±0.53	7.57±0.53	7.71±0.49	7.45^{ab}±0.50
	14	7.29±0.49	7.14±0.69	7.29±0.49	7.14±0.38	7.43±0.53	7.57±0.53	7.71±0.49	7.37^{ab}±0.53
	21	6.57±0.53	7.00±0.82	7.14±0.38	6.86±0.69	7.29±0.49	7.43±0.53	7.57±0.53	7.24^{b}±0.60
	Main effects	7.14^{d}±0.59	7.21^{cd}±0.63	7.36^{bcd}±0.49	7.18^{d}±0.55	7.50^{abc}±0.51	7.61^{ab}±0.50	7.71^{a}±0.46	
Overall Acceptance (100)	1	74.71±1.25	73.14±3.29	72.14±2.41	72.57±2.57	78.71±1.11	82.00±1.63	84.71±1.25	76.86^{a}±5.07
	7	73.57±0.98	73.00±2.08	72.00±2.24	72.29±3.04	78.29±1.70	81.71±1.98	84.57±0.53	76.49^{a}±5.08
	14	73.00±1.53	73.43±2.57	71.86±1.07	72.14±2.19	78.71±1.89	80.86±1.21	83.86±1.21	76.27^{a}±4.80
	21	72.43±2.64	72.14±2.85	71.43±2.82	71.57±1.51	79.14±1.46	80.71±2.56	84.43±2.07	75.98^{a}±5.46
	Main effects	73.43^{d}±3.02	72.93^{de}±2.62	71.86^{e}±2.12	72.14^{e}±2.29	78.71^{c}±2.76	81.32^{b}±3.45	84.39^{a}±3.51	

*Means are average from three independent trials.

abcd.. Means in the same column and row with different letters differ significantly at (P< 0.05).

However, colour and appearance scores decreased gradually for all yoghurt samples with increasing storage period. The results are in agreement with findings of **Salwa et al., (2003)** who reported a decrease in score of appearance of yoghurts during storage period.

In general, yoghurt fortified with date fiber had a brownish color, whereas yoghurt fortified with orange fiber had a yellowish color. However, the panelists showed preference for the lighter colour of yoghurt fortified with orange fiber. **Staffolo et al., (2004)** reported that fortification with commercial wheat, bamboo, or inulin fibers had no effect on yoghurt color. This indicated that yoghurt color is dependent on the color of the fiber source.

According to the results of sensory evaluation, yoghurt fortified with orange fiber got the best scores results for overall acceptability followed by date fiber and control yoghurts, whereas control yoghurt caused an unpleasant taste and lower in body and texture scores. However, the fortification level of the fiber had a significant effect ($P<0.05$) on the yoghurt overall acceptability. This finding is in agreement with **(Sendra et al., 2008** and **Staffolo et al., 2004)** they reported that, orange enriched fermented milks got the best results for overall acceptability followed by control and lemon milks.

Conclusion:

The results of this study indicated that fortification of camel's yoghurts with orange fibers improved the texture, viscosity and reduced whey syneresis of yoghurts. Orange fibers presence in fermented camel milks also enhanced bacterial growth and survival of probiotic bacteria. Sensory analysis results indicated that 4.5% orange fiber is an ideal amount to add in camel's yoghurt production. Panelists gave the highest Flavor, texture, appearance and overall acceptability scores to the yoghurt fortified with orange fiber than control or date fiber. The addition of 4.5% orange fiber to yoghurts appear to be a promising avenue for increased fiber intake, with high consumer acceptability. This work not only provides a solution method for the orange juice industry in Egypt to turn the waste into treasure, but also extends the potential utilization of orange by-products into the dairy industry, with benefits to both nutrition and product texture.

References:

1. AACC. (2001). Approved methods of American Association of Cereals Chemists. The American Association of Cereal Chemists, St. Pauls Minnessota, USA.
2. Abbas, S., Ashraf, H., Nazir, A. and Sarfraz, L. (2013). Physico-chemical analysis and composition of camel milk. International Research Journal, 2, 84-98.
3. Abdul-Hamid, A. and Siew luan, Y. (2000). Functional properties of dietary fiber prepared from defatted rice bran. Food Chem, 68, 15-19.
4. Agrawal, R. P., Budania, S., Sharma, P., Gupta, R., and Kochar, D. K. (2007). Zero prevalence of diabetes in camel milk consuming Raica community of north-west Rajasthan, India. Diabetes Research and Clinical Practice, 76, 290-296.
5. Akalin, A. S., Unal, G., Gonc, S. and Fenderya, S. (2008). Effects of whey protein concentrate and fructooligosaccharide on the rheological and sensory properties of reduced-fat probiotic yoghurt. Milchwissenschaft, 63, 171- 174.
6. Al Haj, O.A. and Al Kanhal, H.A. (2010).Compositional, technological and nutritional aspects of dromedary camel milk - a Review. International Dairy Journal, 20, 811-821.
7. American Public Health Association (APHA) (1992). Compendium of Methods for the Microbiological Examination of Foods, 3rd ed. APHA, Washington, DC.
8. Association of Official Analytical Chemists (AOAC) (2005) Official Methods of Analysis of the Association Analytical Chemists, 18th edn. Gaithersburg, MD: AOAC.
9. Bakirci, I. and Kavaz, A. (2008). An investigation of some properties of banana yoghurts made with commercial ABT-2 starter culture during storage. International Journal of Dairy Technology, 61, 3, 270-276.
10. Benkerroum, N. (2008). Antimicrobial activity of lysozyme with special relevance to milk. African Journal of Biotechnology, 7, 4856-4867.
11. Bravo, L. and Saura-Calixto, F. (1998) Characterization of dietary fiber and the *in vitro* indigestible fraction of grape pomace. Am. J. Enology and Viticulture . 49, 135-141.
12. Caprez, A., Arrigoni, E., Amado, R. and Zeukom, H. (1986). Influence of different types of thermal treatment on the chemical composition and physical properties of wheat bran. Journal of Cereal Science, 4, 233–239.
13. Chaplin, M.F and Kennedy, J.F. (1986). Carbohydrate analysis. A practical approach. Oxford: IRL Press.
14. Coggins, P. C., Rowe, D. E., Wilson, J. C. and Kumari, S. (2010).Storage and temperature effects on appearance and textural characteristics of conventional milk yoghurt. J. Sens. Stud., 25, 549-576.
15. Crizel, D.T., Jablonski, A., De Oliveira Rios, A., Rech R. and Hickmann Flôres, S.(2013). Dietary

fiber from orange byproducts as a potential fat replacer. LWT - Food Science and Technology, 53, 9-14.
16. Damin, M. R., Sivieri, K., and Lannes, S. C. S. (2009). Bebidas lácteas fermentadas e não fermentadas eseu potencial funcional. In M. N. R. Oliveira (Ed.), Tecnologia de produtos lácteos funcionais (1st ed.). (pp. 321-344) São Paulo: Atheneu.
17. Donkor, O. N., Nilmini, S. L., Stolic, I. P., Vasiljevic, T. and Shah, N. P. (2007). Survival and activity of selected probiotic organisms in set-type yoghurt during cold storage. Int. Dairy J., 17, 657–665.
18. El-Agamy, E. I., Nawar, M., Shamsia, S. M., Awad, S. and Haenlein, G. F. W. (2009). Are camel milk proteins convenient to the nutrition of cow milk allergic children? Small Ruminant Research, 82, 1-6.
19. Elleuch, M., Besbes, S., Roiseux, O, Blecker, C., Deroanne, C. Drira, N. E., and Attia, H.(2008). Date flesh: Chemical composition and characteristics of the dietary fiber. Food Chemistry, 111, 676-682.
20. Elleuch, M., Bedigian, D., Roiseux, O., Besbes, S., Blecker, C. and Attia, H. (2011). Dietary fiber and fiber-rich by-products of food processing: Characterisation, technological functionality and commercial applications. Revue of Food Chemistry, 124, 411–421.
21. El-Nagar, G.F. and Shenana, M.E. (1998). Production and acceptability of bio-yoghurt. Proc. 7 th Egyptian Conf. Dairy Sci. and Techn., 227-232.
22. Espírito Santo, A.P., Silva, R.C., Soares, F.A.S.M., Anjos, D., Gioielli, L.A. and Oliveira, M.N. (2010). Açai pulp addition improves fatty acid profile and probiotic viability in yoghurt. International Dairy Journal, 20, 415–422.
23. Farag, S. I., El-Sonbaty, A.H., Hussein, S. A., Farrag, A. F. and Shahine, A. M. (2007). Effect of substituting added skim milk powder (SMP) with wheat Germ (WG) on the quality of goat's milk yoghurt and fermented camel's milk drink. Proc. 10th Egypt. Conf. Dairy Sci. and Technol., 315-336.
24. Fernández-García, E., and McGregor, J. U. (1997). Fortification of sweetened plain yoghurt with insoluble dietary fiber. Zeitschrift fur Lebensmittel-Untersuchung und -Forschung. A, European food research and technology, 204(6), 433–437.
25. Fernández-García, E., McGregor, J.U. and Traylor, S., (1998). The addition of oat fiber and natural alternative sweeteners in the manufacture of plain yoghurt. J. Dairy Sci.,81 (3), 655–663.
26. Fernández -Gines, J. M., Fernández-López, J., Sayas-Barbera, E., and Perez-Alvarez, J. A. (2003). Effects of storage conditions on quality characteristics of bologna sausages made with citrus fiber. J. Food Sci., 68(2), 710–715.
27. Fernández-López, J., Fernández-Gine´s, J. M., Aleson-Carbonell, L., Sendra, E., Sayas-Barbera´, E., and Pérez-Alvarez, J. A. (2004). Application of functional citrus by-products to meat products. Trends in Food Science and Technology, 15, 176–185.
28. Fernández-López, J., Sendra-Nadal, E., Navarro, C., Sayas, E., Viuda-Martos, M., and Pérez-Alvarez, J. A. P. (2009). Storage stability of a high dietary fiber powder from orange by-products. International Journal of Food Science and Technology, 44, 748-756.
29. Figuerola, F., Hurtado, M. L., Estévez, A. M., Chiffelle, I. and Asenjo, F.(2005). Fiber concentrates from apple pomace and citrus peel as potential fiber sources for food enrichment. Food Chemistry, 91, 395-401.
30. García-Pérez, F.J., Lario, Y., Fernández-López, J., Sayas, E., Pe´rez-Alvarez, J.A. and Sendra, E., (2005). Effect of orange fiber addition on yoghurt color during fermentation and cold storage. Color Res. Appl., 30 (6), 457–463.
31. García-Pérez, F.J, Sendra, E, Lario, Y., Fernández-López, J., Sayas, E. and Pérez-Alvarez, J.A. (2006). Rheology of orange fiber enriched yoghurt. Milchwissenschaft, 61: 55-59.
32. Grigelmo-Miguel, N., and Martin-Belloso, O. (1998). Characterization of dietary fiber from orange juice extraction. Food Research International, 31(5), 355–361.
33. Guler-Akin, M. B. and Akin, M. S.(2007). Effects of cysteine and different incubation temperatures on the microflora, chemical composition and sensory characteristics of bio-yoghurt made from goat's milk. Food Chemistry, 100(2), 788–793.
34. Hashim, I.B., Khalil, A. H. and Habib, H. (2009). Quality and acceptability of a set-type yoghurt made from camel milk. J. Dairy Sci., 92, 857–862.
35. Ibrahim, A. H. and Khalifa. S. A. (2015). The effects of various stabilizers on physiochemical properties of camel milk yoghurt. Journal of American Science,11(1) 15-24.
36. Ibrahim, G.A., Mehanna, N.S. and Gad El-Rab, D.A. (2004). Preparation and properties of set fermented milk containing inulin and different probiotics. Proc. 9th Egyptian Conf. Dairy Sci. and Techn., 117-121.
37. Jumah, R. Y., Shaker, R. R., and Abu-Jadayil, B. (2001). Effect of milk source on the rheological

properties of yoghurt during the gelation process. International Journal of Dairy Technology, 54, 89-93.

38. Kailasapathy, K., Harmstorf, I. and Philips, M. (2008). Survival of *Lactobacillus acidophilus* and *Bifidobacterium animalis spp. Lactis* in stirred fruit yoghurts. Journal of LWT-Food Science and Technology, 41, 1317–1322.
39. Kappeler, S., Farah, Z., and Puhan, Z. (1998). Sequence analysis of *Camelus dromedaries* milk caseins. J. Dairy Res., 65, 209-222.
40. Konuspayeva, G., Faye, B., Loiseau, G., and Levieux, D. (2007). Lactoferrin and immunoglobulin contents in camel's milk (*Camelus bactrianus*, *Camelus dromedariu*s, and hybrids) from Kazakhstan. J. Dairy Sci., 90,38-46.
41. Laniewska-Trokenheim, L., Olszewska, M., Miks-Krajnik, M. and Zadernowsk, A.(2010). Patterns of survival and volatile metabolites of selected Lactobacillus strains during long-term incubation in milk. Journal of Microbiology, 48 (4), 445–451.
42. Lankaputhra, W. E. V. and Shah, N. P. (1995). Survival of *Lactobacillus acidophilus* and Bifidobacterium spp. in the presence of acid and bile salts. Cultured Dairy Products Journal, 30, 2–7.
43. Lankaputhra, W. E. V., Shah, N. P. and Britz, M. L. (1996). Evaluation of media for selective enumeration of *Lactobacillus acidophilus* and *Bifidobacterium* s*pp*. Food Australia, 48, 113-118.
44. Lario, Y., Sendra, E., García-Pérez, J., Fuentes, C., Sayas-Barberá, E. and Fernández-López, J. (2004). Preparation of high dietary fiber powder from lemon juice by-products. Innovative Food Science and Emerging Technologies, 5, 113-117.
45. Lee, W. J. and Lucey, J. A. (2010). Formation and physical properties of yoghurt. Asian-Australasian Journal of Animal Sciences, 23(9), 1127–1136.
46. Luz Fernandez, M. (2001). Pectin: Composition, chemistry, physicochemical properties, food applications and physiological effects. In S. Sungsoo Cho & M. S. Dreher (Eds.), Handbook of dietary fibre. New York: Taylor and Francis Group LCC.
47. MacConnell, A. A., Eastwood, A. and Mitchell, W.D.(1974). Physical characterization of vegetable foodstuffs that could influence bowel function. Journal of the Science Food and Agricultural, 25, 1457–1464.
48. Magjeed, N. A. (2005). Corrective effect of milk camel on some cancer biomarkers in blood of rats intoxicated with aflatoxin B1. Journal of the Saudi Chemical Society, 9, 253-263.
49. Marín, F. R., Soler-Rivas, C., Benavente-García, O., Castillo, J. and Pérez-Alvarez, J. A. (2007). By-products from different citrus processes as a source of customized functional fibers. Food Chemistry, 100, 736-741.
50. Mortada, M. S. and Omer, I. A. H. (2013). Effect of fortifying camel's milk with skim milk powder on the physicochemical, microbiological and sensory characteristics of set yoghurt. Advance Journal of Food Science and Technology, 5(6), 765-770.
51. Ndife J., Idoko F. and Garba, R. (2014). Production and quality assessment of functional yoghurt enriched with coconut. International Journal of Nutrition and Food Sciences,3(6): 545-550.
52. Oliveira, R.P.S., Florence, A.C.R., Silva, R.C., Perego, P., Converti, A., Gioielli, L.A. and Oliveira, M.N. (2009). Effect of different prebiotics on the fermentation kinetics, probiotic survival and fatty acid profiles in nonfat symbiotic fermented milk. International Journal of Food Microbiology, 128, 467–472.
53. Osundahunsi, O., Amosu, D. and Ifesan, B. (2007). Quality evaluation and acceptability of soy-yoghurt with different colours and fruit flavours. American Journal of Food Technology, 2(4): 273-280.
54. Prosky, L., Asp, N. G., Schweizer, T. F., De Vries, J. W. and Furda, I. (1988). Determination of insoluble, soluble, and total dietary fiber in food products: Interlaboratory study. Journal of Association Official Analytical Chemists, 71, 1017–1023.
55. Rybka, S., and Kailasapathy, K. (1995). The survival of culture bacteria in fresh and freeze-dried AB yoghurts. Australian Journal of Dairy Technology, 50, 51–57.
56. Sahan, N., Yasar, K. and Hayaloglu, A. A. (2008). Physical, chemical and flavor quality of non-fat yoghurt as affected by a β-glucan hydrocolloidal composite during storage. Food Hydrocoll, 22:1291–1297.
57. Sakandar, H.A., Imran, M., Huma, N., Ahmad, S. and Aslam, H.K.W. (2014). Effects of polymerized whey proteins isolates on the quality of stirred yoghurt made from camel milk. J. Food Process Technol., 5, 350-355.
58. Salwa A.A., Galal, E.A. and Elewa, N.A. (2003). Carrot yoghurt: sensory, chemical, microbiological properties and consumer acceptance. Pakistan Journal of Nutrition, 3: 322-330.

59. Sandoval-Castilla, O., Lobato-Calleros, C., Aguirre-Mandujano, E. and Vernon-Carter, E. J.(2004). Microstructure and texture of yoghurt as influenced by fat replacers. Int. Dairy J., 14, 151–159.
60. Seçkin, A. K and Baladura, E. (2012).Effect of using some dietary fibers on color, texture and sensory properties of strained yoghurt. GIDA. 37 (2): 63-69.
61. Sendra, E., Fayos, P., Lario, Y., Fernández-López, J., Sayas-Barbera, E. and Pérez-Alvarez, J. A. (2008). Incorporation of citrus fibers in fermented milk containing probiotic bacteria. Food Microbiology, 25 :13–21.
62. Sendra, E., Kuri, V., Fernández-López, J., Sayas-Barberá, E., Navarro, C., and Pérez-Alvarez, J. A. (2010). Viscoelastic properties of orange fiber enriched yoghurt as a function of fiber dose, size and thermal treatment. LWT – Food Science and Technology, 43(4), 708–714.
63. Shah, N. P. (2000). Probiotic bacteria: Selective enumeration and survival in dairy foods. J. Dairy Sci., 83, 894–907.
64. Shah, N. P., and Jelen, P. (1990). Survival of lactic acid bacteria and their lactases under acidic conditions. Journal of Food Science, 55, 506–509.
65. Soukoulis, C., Lebesi, D. and Tzia, C. (2009). Enrichment of ice cream with dietary fiber: Effects on theological properties, ice crystallization and glass transition phenolmena. Food Chemi, 115: 665.
66. SPSS; Version 18 (2012). Software package for Social Science For windows SPSS package (SPSS v.18, Chicago, II 60611, USA, 2012).
67. Staffolo, M.D., Bertola, N., Martino, M., and Bevilacqua, Y.A. (2004). Influence of dietary fiber addition on sensory and rheological properties of yoghurt. International Dairy Journal, 14 (3), 263-268.
68. Taha, S. H., El Abd M.M., Khalil, E. M. and Hassan, D. F. (2011). Influence of orange fibers and *Bifidobactfrium longum* ATCC15708 on the properties of flavoured stirred yoghurt. Egyptian. J. Dairy Sci., 39: 229-241.
69. Tamime, A.Y. and Robinson, R.K. (1999). Yoghurt. Science and Technology. Cambridge, UK: Woodhead Publishing Limited England.
70. Tarakci, Z. and Kucukoner, E. (2003). Physical, chemical, microbiological and sensory characteristics of some fruit-flavored yoghurt. YYÜ Veteriner Fakul Tesi Dergisi, 14 (2):10-14.
71. Thebaudin, J. Y., Lefebvre, A. C., Harrington, M., and Bourgeois, C. M. (1997). Dietary fibers: nutritional and technological interest. Trends in Food Science and Technology, 8, 41-48.
72. Torriani, S., Gardini, F., Guerzoni, M.E. and Dellaglio, F. (1996). Use of response surface methodology to evaluate some variable affecting the growth and acidefication characteristics of yoghurt cultures. Int. Dairy J., 6, 625-636.
73. Tsevdou, M. S., Eleftheriou Evangelia, G. and Taoukis Petros, S. (2013). Transglutaminase treatment of thermally and high pressure processed milk: Effects on the properties and storage stability of set yoghurt. Innovative Food Science and Emerging Technologies, 17, 144-152.
74. 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, 221–226.

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