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CHARACTERISTICS OF FUNCTIONAL SYNBIOTIC CAMELS' FERMENTED MILK (LIKE- YOGURT) PRODUCTS

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ABSTRACT

Preparing synbiotic fermented camel milk like- yogurt products (SFCMPs) fortified with different cereals was the main target of this study. Cereals used were hulless barley, oat, triticale and durum wheat in flour form. Honey is used as natural prebiotic. Yogurt starter (containing Lb. delbrueckii ssp. bulgaricus and Str. thermophilus) culture and AB-sweet (containing Lb. acidophilus & bifidobacteria) as probiotic starter culture were used to prepare different camel milk like- yogurt products. The physicochemical, textural, microbiological and sensory properties of SFCMPs were examined during storage period at 6±1°C for 9 days. The nutritional and daily values of the fresh prepared SFCMPs were also calculated. All treatments were significantly differed ($p \leq 0.05$) in their properties; depending on the type of cereal's, starter culture and storage period. The SFCMPs containing triticale and durum wheat flour showed higher moisture, fat and total protein percent and whey separation values than that of oat and hulless barely. Meanwhile, the highest values of crude fiber, ash, acetaldehyde & diacetyle, and dynamic viscosity values as well as bacterial counts were noticed in SFCMPs containing oats and barley. Lower amounts of acetaldehyde & diacetyle, dynamic viscosity and pH values with higher whey separation showed with yoghurt starter treatments than that of probiotic starter. The viable cell counts in all SFCMPs were maintained at an acceptable level (>106CFU/ml) to be considered as functional foods until the end of storage period. The Textural characteristics as hardness and gumminess were negatively correlated to cohesiveness and springiness in all SFCMPs throughout the storage period. The SFCMPs made with oat displayed the highest organoleptic scores throughout the storage period particularly when fermented with AB-sweet starter culture. Therefore, SFCMPs can be recommended as new nutritional and functional products from camels' milk with good organoleptic properties.

Keywords: Synbiotic fermented products, camels' milk, cereals, nutritional and daily values.

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INTRODUCTION

Fermented milk products are widely consumed and produced world-wide using various manufacturing techniques, raw materials and microorganisms. Their popularity is attributed to its nutritional value, pleasant and appealing properties (Nout et al., 2007). These products already have a positive health image, which can be further enhanced by the addition of probiotic bacteria with therapeutic properties (Valli and Traill, 2005). The use of milk with particular nutritional properties such as camel milk, in combination with bacterial strains having probiotic properties represents one of the technology options for manufacturing dairy functional products (Gobbetti et al., 2010).

Camel milk contains all essential nutrients as cow milk but differ from it in the absence of β-lactoglobulin and high protective whey proteins such as lactoferrin (ten times higher than in cows' milk). Furthermore, camel milk exhibited anti-viral, anti-bacterial properties and had high immunoglobulin content which confer its high antimicrobial properties (Korashy et al., 2012). It is well known that, camel milk has potential therapeutic properties, such as anti-carcinogenic, antihypertensive and anti-diabetic (Sharma & Singh, 2014). Also, it has been recommended for consumption by children who are allergic to bovine milk and in the manufacture of infant formula (Gul et al., 2015).

Cereals are grown over 73% of the total world harvested area and contribute over 60 % of the world food production providing dietary fiber, saccharides (especially starch), proteins, minerals, vitamins and phytochemicals with antioxidant properties required for human health (Jones et al., 2008). However, the nutritional quality of the cereals and the sensorial properties of their products are sometimes inferior or poor in comparison with milk and milk products. Fermentation may be the most simple and economical way of improving their nutritional values, sensory properties and functional qualities During cereal fermentations several volatile compounds are formed, the presence of aromas such as diacetyl acetic acid and butyric acid make fermented cereal-based products more appealing (Blandino et al., 2003).

Nowadays, cereals alone or mixed with other ingredients are used for the production and development of new functional products with enhanced healthy properties using probiotic strains (Charalampopoulos et al., 2009). In this respect, the possible applications of cereal constituents in functional food applications could be summarized: a-as fermentable substrates for growth of probiotics microorganisms, especially lactobacillus and bifidobacterium; b-as dietary fiber promoting several beneficial physiological effects; c-as prebiotics due to their content of specific non digestible carbohydrates and d- as encapsulation materials for probiotics in order to enhance their stability (Charalampopoulos et al., 2002).

Numbers of fermented products based on milk or curd have been prepared by using probiotic micro-organism, but until now, much less work has been done on the development of probiotic fermented products based on cereals (Gehan, 2011 and Marwa et al., 2015). Consequently, the current focus study was planned on the possibility of manufacture novel healthy synbiotic fermented camel milk like yogurt products with new cereal's flour pastes (as natural prebiotic source) as well as using beneficial probiotics in order to serve new camel milk products with high functionality, nutritional value and acceptability.

MATERIALS AND METHODS

Materials

1- Fresh raw camels' milk was collected from camels' herd belongs to Desert Research Center at North Western Coastal area, Matrouh, Governorate, Egypt. Milk was immediately maintained and stored under refrigerated conditions until used. Bulk camels' milk samples contained 12.52 ±0.96 % total solids, 3.82 ±0.76% fat, 3.56 ±0.68% total protein, 4.32 ±0.51% carbohydrates (by difference) , 0.82±0.05% ash and pH of 6.7 ±0.43.

2- Four different commercial cereals flour namely; (*Hordeum vulgare* L.) the cv. Falcon hulless barely, oat (*Avena sativa* L.) the cv. Ozark , (*Triticale octoploide* spp) triticale the cv. Lasko and Durum wheat the cv. ACSAD 1105 (*Triticum Durum* L.), were obtained from Cereal program, The Arab Center for the Studies of Arid zones and Dry lands (ACSAD). The chemical composition of different cereal's flour used in the manufacture of synbiotic fermented camels' milk is presented in **Table 1.**

3- Black cumin honey was obtained from Marriott Station, Desert Research Center, Egypt.

4- Two commercial freeze-dried DVS mixed bacterial starters of Yo-Fast1 (containing of *Lactobacillus* (*Lb.*) *delbrueckii* ssp. *bulgaricus* & *Streptococcus* (*Str.*) *thermophilus*) as yoghurt starter and AB- sweet (containing of *Lb. acidophilus* and bifidobacteria) with potential probiotic properties starters (Chr. Hansen Laboratory Copenhagen, Denmark) were used in the fermentation process. Freeze-dried bacterial starters used in the fermentation process were prepared separately as mother cultures in autoclaved (121˚C/10 min) fresh skim milk (0.1 % fat and 9.5% SNF) using a 0.02 % (w/v) inoculums. The cultures were incubated at 40˚C for CH-1starter and 37˚C for AB- sweet starter, until curdling of milk. Cultures were prepared 24h before use.

Methods

1. Manufacture of synbiotic fermented camels' milk like yogurt product

The manufacture of synbiotic fermented camels' milk was done based on the results of the preliminary trials, based on the sensory results of the final products (i.e., with the highest intensities), in an attempt to improve the texture and acceptability of the final product. Accordingly Camel milk was mixed with different cereal's flour (about 7%) to contain final blends with approximately 20% total solids and fortified with 3% honey. All different blends (camel milk with different cereal's flour) were heated separately in a water bath to 85˚C/30 min, and cooled to 45˚C, then honey was added. Next each type of blend was divided into two parts. The first one was cooled to 40˚C and the second to 37˚C for inoculation with 3% (v/v) of CH-1 and AB-sweet mother cultures, respectively. Then different treatments were poured into 150 ml plastic cups and incubated to ~ 3 h for CH-1culture and ~ 4 h for AB-sweet culture, then immediately cooled and stored for 9 days at 6±0.5˚C. The final fermented cereal-based camels' milk products were analyzed to physicochemical , microbiological, dynamic viscosity, pH values and organoleptic properties throughout storage (zero, 3, 6 and 9) days at 6±0.5˚C.

3. Chemical and physicochemical analysis

Cereal flours were analysed for moisture content (by dry oven method), fat (using Soxhlet method), total nitrogen (using micro-Kjeldahel method); crude fiber and ash (using Thermolyne, type 1500 Muffle Furnace) contents according to the methods described by Nielsen (1998). Camel milk and synbiotic fermented like yogurt products were analysed for total solids and moisture content (by dry oven method) , fat (using Gerber method), total nitrogen (using micro-Kjeldahel method); and ash (using Thermolyne,type 1500 Muffle Furnace) contents, ; as well as pH values (using digital pH meter, Inolad model 720, Germany) according to AOAC (2012). All Minerals contents were measured in the ash as described by Kondyli et al., (2007). Ca, Fe, and Mg determined using Atomic absorption 3300 Perkin Elmer U.S.A. Meanwhile Na and K concentrations were detected using a Corning 410 Flame Photometer (Ciba Corning Diagnostics Scientific Instruments, Essex, England). Also, Phosphorous (P) was estimated calorimetrically in the ash according to AOAC (2012). Vitamins A and E (α–tocopherol) were determined using HPLC method as described by Leth and Sonderyaro (1993). Vitamins B1, B2 and B6 were determined by HPLC analysis according to Albala-Hurtado et al., (1997). Synersis was measured as described by Farouq &Haque (1992) as the amount of spontaneous whey (ml /100g) drained off after 2 h at 7˚C when fresh and during storage. Acetaldehyde and diacetyl (µmol/ml) contents were determined according to Lees and Jago (1969) and (1970), respectively.

Viscosity was measured using a Brookfield digital viscometer (Brookfield Engineering Laboratory Inc., Stoughton, MA) Model DV- II with a helipath stand mounted with a spindle -00, that rotated at different rpm ranged from (20-200) at shear rates ranging from 46.39 to 243.58 s-1. Data were collected using Wingather soft ware (Brookfield Engineering Laboratory Inc., Stoughton, MA). Shear stress values (dyne/cm2) was recorded at 22 ±1º C during storage period (Fresh and after 3, 6 and 9 days) for all samples, as formerly described by Djurdjevic' et al., (2001). Three readings, 40s apart, were recorded for each sample. Dynamic viscosity (cP) was calculated at a constant shear rate of112.12 s^{-1}.

Textural properties was measured using a Texturometer model Mecmesin Emperor TM Lite .17 (USA). Mechanical primary characteristics of Hardness, Springiness, Gumminess and Cohesiveness were determined from the deformation Emperor TM Lite Graph. Also, the secondary characteristic of Chewiness and Adhesivenss was detected according to Lobato-Calleros et al., (1998).

4. Bacteriological analysis

Samples of all cereal-based fermented camel's milk were prepared for bacteriological analysis according to the method described in the Standard Methods for the Examination of Dairy Products (Wehr & Frank, 2004). Viable counts of *lactobacillus delbrueckii* ssp. *bulgaricus* on MRS agar (pH 5.2)(Anaerobic incubation at 45˚C for 72h), *lactobacillus acidophilus* on MRS – sorbitol agar (Anaerobic incubation at 37˚C for 72h), *Streptococcus thermophilus* on ST agar (Aerobic incubation at 37˚C for 24h) and bifidobacteria on MRS agar (Oxoid) supplemented with L-cystein and lithium chloride (Sigma Chemical CO., USA) (Anaerobic incubation at 37˚C for 72h) were enumerated as described by Dave & Shah (1996). The plates were incubated in an anaerobic environment (BBLGas Pak, Becton Dickinson Microbiology Systems). The results expressed as log conoly forming unit (log_{10} cfu)/ml of sample.

5. Sensory evaluation

Synbiotic fermented camel's milk treatments were subjected to sensory analysis by 20 panelists of the staff member at Animal Production Division, Desert Research Center, Cairo, Egypt according to the scheme described by Clark et al., (2009). All cheese samples were evaluated when fresh (one day) and throughout storage up to 9 days at 6±0.5˚C. The sensory attributes evaluated were: flavour (1-10points), body and texture (1-5 points) and appearance & colour (1-5points).

6. Nutritional value of products

Nutritional value of nutrients in all treatments was calculated using food tables (FDA,2004 a) and the local food composition tables of Nutrition Institute (Annon, 1996 & Saad et al., 1997)

7- Statistical analyses

All experiments and analysis were done in triplicate. Statistical analyses were carried out using the General Liner Models procedure of the SPSS 16.0 Syntax Reference Guide (SPSS, 2007) The results were expressed as least squares means with standard errors of the mean. Statistically different groups were determined by the LSD (least significant difference) test ($p \leq 0.05$).

RESULTS AND DISCUSSION

Physico-chemical properties of fresh (after 24 h of refrigerated storage) synbiotic camels' milk like- yogurt products

The effect of type of cereal's flour on chemical composition of resultant camels' milk products was more pronounced ($p \leq 0.05$) than that of type of starter culture used ($p \geq 0.05$) (Table 2). These results were in agreement with those obtained by Akalin (1996), who stated that, the type of culture used in the fermentation had no effect on the total solids, total protein, fat and total carbohydrate contents of yoghurt. Also, treatments fermented with AB-sweet showed slight decrease in total protein content than that made using yoghurt starter culture (CH-1). This may be due to the limited proteolysis of milk protein by lactic acid bacteria, same findings reported by Salama (2002). Moreover, there were no significant differences ($p \geq 0.05$) found in the fat, crude fiber and ash contents, but significant ($p \leq 0.05$) in the total solids and total protein contents among different camels' milk products, depending on the type of starter culture. Among treatments, products containing of tritical's flour were characterized with the highest contents of fat and protein. While, containing of oat were characterized with the highest contents of crude fiber and ash but lowest contents of fat and total protein.

These differences in chemical properties of different treatments could be due to the chemical composition of cereal's flour used (**Table 1**). The type of cereal's flour in side and starter culture used in the fermentation on the other side significantly affected ($p \leq 0.05$) the syneresis amounts. Treatments containing tritical' and durum wheat showed higher spontaneous whey separation (ml/100g) than that containing barely and oat. Also, treatments fermented with CH-1culture had higher amounts of whey separation than that with AB-sweet culture. This could be due to that, some strains of lactic acid bacteria used in the manufacture of fermented milk may produce exopolysaccharides, which affect syneresis of fermented products (Purohit et al., 2009).

The changes in acetaldehyde and diacetyl contents are also shown in Table (2). Data reveled that, the acetaldehyde and diacetyl contents in all treatments were significantly influenced ($p \leq 0.05$) by both the type of cereal and the starter used in the fermentation. The highest amounts of acetaldehyde and diacetyl were observed in treatments containing barley followed by that containing oat. On the other side, camel's milk treatments fermented with CH-1 starter culture was characterized with the lower amounts of acetaldehyde and diacetyl than that with AB-sweet. Also, Salmeron et al., 2009 reported that, the production of volatile compounds by the probiotic strain; *Lactobacillus plantarum* NCIMB 8826; in cereal-based media containing durum wheat, oat, barley and malt are depending more on the substrate than on the microorganism.

As shown from **Table (3),** the pH values varied among different treatments according to the type of cereal's flour or starter culture used as well as time of the storage ($p \leq 0.05$).

It could be noticed from the presented data that; fermented products containing oat and barely characterized with lower pH values as compared with that containing triticale and durum wheat either when fresh or during storage period (6±1˚C for 9 days). On the other side, treatments fermented with yoghurt starter culture were characterized with lower pH values during storage period, as compared with that made by probiotic starter culture. The higher acidity of treatments made with yoghurt starter could be attributed to the high activity of lactose

Table (1): Chemical composition (Mean± Standard deviation) of different cereal's flour

Chemical composition (%)	Cereal's flour pastes			
	Hulless barely	Oat	Triticale	Durum wheat
Total solid	**90.1±0.25**	**89.58±0.22**	**93.10±0.28**	**91.07±0.26**
Fat	**0.6±0.01**	**1.02±0.08**	**0.66±0.05**	**0.49±0.03**
Total protein	**3.65 [1] ±0.12**	**3.13 [1] ±0.10**	**4.12 [2] ±0.13**	**3.68 [3] ±0.11**
Crude fiber	**1.74±0.09**	**3.21±0.11**	**0.82±0.06**	**0.69±0.04**
Ash	**0.85±0.07**	**0.95±0.10**	**0.76±0.07**	**0.60±0.03**

[1]Total protein (%) = N×5.36 ; [2]protein (%) = N×5.17 ; [3]protein (%) = N×5.33

Table (2): Physicochemical properties of fresh synbiotic camels' milk like-yogurt products.

Physicochemical properties	Type of starter	Control	Type of cereal's flour			
			Hulless barely	Oat	Triticale	Durum wheat
TS	**CH-1***	**12.87^{Cc}±0.10**	**21.66^{Aa}±0.34**	**21.92^{Aa}±0.32**	**20.72^{Bb}±0.30**	**20.36^{Bb}±0.29**
	AB-sweet**	**12.84^{Cc} ±0.11**	**21.63^{Aa}±0.33**	**21.88^{Aa}±0.30**	**20.68^{Bb}±0.28**	**20.32^{Bb}±0.27**
Fat%	**CH-1**	**3.93±0.10^{Aa}**	**1.88^{CDcd}±0.07**	**1.74^{Cc}±0.06**	**1.98^{Bb}±0.09**	**1.92^{BCbc}±0.08**
	AB-sweet	**3.93±0.09^{Aa}**	**1.88^{CDcd}±0.08**	**1.74^{Cc}±0.07**	**1.98^{Bb}±0.09**	**1.92^{BCbc}±0.07**
Total protein (N×6.38)	**CH-1**	**3.75^{Cc}±0.10**	**4.09^{Bbc}±0.11**	**3.64^{Cc}±0.09**	**4.21^{Aa}±0.12**	**4.14^{ABab}±0.12**
	AB-sweet	**3.73^{Cc}±0.11**	**4.04^{BCbc}±0.08**	**3.58^{Cc}±0.07**	**4.14^{ABab}±0.11**	**4.08^{Bb}±0.10**
Total carbohydrate [1]%	**CH-1**	**4.39^{Dd}±0.12**	**12.78^{Aa}±0.11**	**12.18^{Cc}±0.10**	**12.37^{Bb}±0.11**	**12.30^{BCbc}±0.14**
	AB-sweet	**4.40^{Dd}±0.11**	**12.80^{Aa}±0.12**	**12.20^{Cc}±0.09**	**12.40^{Bb}±0.12**	**12.32^{BCbc}±0.13**
Ash%	**CH-1**	**0.88^{C}±0.05**	**1.92^{A}±0.07**	**1.97^{A}±0.08**	**1.78^{B}±0.07**	**1.70^{B}±0.06**
	AB-sweet	**0.86^{C}±0.4**	**1.92^{A}±0.08**	**1.97^{A}±0.05**	**1.78^{B}±0.07**	**1.70^{B}±0.07**
Crude fiber%	**CH-1**	**-**	**0.99^{Bb}±0.05**	**2.39^{Aa}±0.09**	**0.38^{Cc}±0.01**	**0.30^{Cc}±0.01**
	AB-sweet	**-**	**0.99^{Bb}±0.06**	**2.39Aa±0.08**	**0.38^{Cc}±0.01**	**0.30^{Cc}±0.01**
Spontaneous syneresis (ml/100g)	**CH-1**	**19.4^{Aa}±0.27**	**16.5^{Cc}±0.21**	**14.2^{Dd}±0.25**	**17.20^{Bb}±0.20**	**17.8^{Bb}±0.22**
	AB-sweet	**18.8^{Aa}±0.23**	**15.2^{Cc}±0.20**	**12.9^{De}±0.19**	**15.80^{BCcd}±0.18**	**16.2^{Bc}±0.14**
Diacetyle (µmol/ml)	**CH-1**	**1.77^{Eg}±0.08**	**29.90^{Ab}±0.26**	**26.80^{Bc}±0.23**	**23.70^{Cd}±0.22**	**20.25^{De}±0.20**
	AB-sweet	**2.98^{Ef}±0.10**	**32.70^{Aa}±0.28**	**29.60^{Bb}±0.26**	**26.50^{Cc}±0.24**	**23.05^{Dd}±0.21**
Acetaldehyde (µmol/ml)	**CH-1**	**32.28^{Eh}±0.18**	**344.4^{Ac}±2.69**	**336.2^{Be}±2.54**	**331.70^{Cf}±2.38**	**325.3^{Dg}±2.32**
	AB-sweet	**34.49^{Eh} ±0.21**	**359.8^{Aa}±2.83**	**350.1^{Bb}±2.77**	**340.22^{Cd}±2.70**	**336.7^{De}±2.61**
Dynamic viscosity (P)	**CH-1**	**0.615^{Ef}±0.01**	**2.524^{Bb}±0.07**	**2.852^{Aab}±0.08**	**1.484^{Cc}±0.05**	**1.106^{Dd}±0.03**
	AB-sweet	**0.733^{Ef}±0.01**	**2.701^{ABab}±0.08**	**3.238^{Aa}±0.09**	**1.588^{Cc}±0.06**	**1.204^{Dcd}±0.04**

[1] : Calculated by the difference.

*: Bacterial starter culture containing of Lactobacillus delbrueckii ssp. bulgaricus and Streptococcus *thermophilus* (as commercial yoghurt starter)

*: Bacterial starter culture containing of *Lactobacillus acidophilus* and bifidobacteria (with potential probiotic properties)

[A, B,C,...]: Means with the different capital [(A, B,...)] superscript letters within the same raw indicate significant (P≤0.05) differences between Type of cereals.

Table (3): Changes in pH values of different synbiotic camels' milk like- yogurt during storage.

Type of cereals	Type of starter culture	Storage period (days)			
		Fersh	3	6	9
Control	**CH-1**	**5.07^{Abc}±0.10**	**5.01^{ABc}±0.11**	**4.94^{BCd}±0.09**	**4.88^{Ce}±0.08**
	AB-sweet	**5.20^{Aa}±0.12**	**5.14^{ABab}±0.10**	**5.09^{BCb}±0.10**	**5.04^{Cc}±0.09**
Hulless barely	**CH-1**	**4.87^{Acd}±0.11**	**4.81^{ABcd}±0.10**	**4.78^{Bd}±0.10**	**4.73^{Bd}±0.09**
	AB-sweet	**5.27^{Aa}±0.13**	**5.21^{ABab}±0.13**	**5.18^{Bb}±0.12**	**5.13^{Bbc}±0.12**
Oat	**CH-1**	**4.89^{Ac}±0.11**	**4.85^{Ac}±0.10**	**4.81^{ABcd}±0.09**	**4.77^{Bd}±0.09**
	AB-sweet	**5.29^{Aa}±0.14**	**5.25^{Aa}±0.13**	**5.20^{ABab}±0.12**	**5.16^{Bb}±0.12**
Triticale	**CH-1**	**4.95^{Ac}±0.12**	**4.91^{Ac}±0.12**	**4.86A^{Bcd}±0.1**	**4.82^{Bd}±0.11**
	AB-sweet	**5.31^{Aa}±0.13**	**5.27^{Aa}±0.12**	**5.22^{ABab}±0.12**	**5.19^{Bb}±0.10**
Durum wheat	**CH-1**	**4.92^{Ad}±0.09**	**4.88^{ABde}±0.09**	**4.83^{BCef}±0.08**	**4.79^{Cf}±0.07**
	AB-sweet	**5.28^{Aa}±0.12**	**5.23^{ABab}±0.11**	**5.17^{BCbc}±0.11**	**5.13^{Cc}±0.11**

A, B, C,…: Means with the different capital (A, B,…) superscript letters within the same raw indicate significant ($P\leq0.05$) differences between Storage period and Type of starter culture.

a,b,c,… : Means with the different small (a, b,…) superscript letters within the same column and property are significantly ($P\leq0.05$) different between Storage period (days) and Type of cereals.

in yoghurt starter splitting lactose (Tamime and Robinson, 2007). During the storage period, significant differences (*p*≤0.05) were recorded in pH values of all treatments. Moreover, a gradual decrease in pH values could be observed in all treatments with extending the storage period. This decrease could be attributed to a limited growth of different bacterial starter cultures and the slow fermentation of lactose residual. Same findings were reported by Barrantes et al., (1994).

Microbiological properties

Significant differences (*p*≤0.05) were found in log bacterial cell counts between different treatments as affected by the type of starter culture or cereal's flour used as well as storage period (Table 4). Generally, the total viable bacterial cells count in all treatments as well as the control decreased (*p*≤0.05) to minimum counts (log_{10} CFU / ml) at the end of storage period. It could be due to the accumulation of acids or reduction of availability of nutrient required for the growth (Kabeir et al., 2015). Among treatments, oat and durum wheat had the highest and lowest percentage survival bacterial counts after 9 days of storage, respectively. A gradual increase in the viable cells counts detected until the 3rd day of storage, then decreased after that. Generally, the survival rate of *str. thermophilus* were prevalent in all treatments, followed by *Lb. delbruecki ssp. bulgaricus* either when fresh or during cold storage. Whereas, the survival rate of *Lb. acidophilus* was higher than that of bifidobacteria in all treatments throughout the storage period.

Meanwhile, Bifidobacteria was exhibited the lowest levels of viable cells in all synbiotic products. The variances in Bifidobacterium survival were interpreted by its metabolic activity in different fermented products, which might be affected by the composition and availability of nitrogen and carbon sources in growth media (Buriti et al., 2014). The present results indicated that, the survival of *Lb. bulgaricus*, *Str. thermophilus, Lb. acidophilus* and bifidobacteria cells during the storage period of all different treatments could be considered satisfactory (>10^6 CFU /ml) until the 9 th day of storage period to be considered as functional foods until the end of the cold storage (Akın et al., 2007). For practical application; a pH value of the final product must be maintained above 4.6 to prevent the decline of bifidobacteria populations (Vinderola et al., 2000). In addition, Sanders & Huis in't Veld (1999) suggested that, the cereal tested can produce LAB populations with higher cell concentrations than the minimum requirement for a probiotic drink (10^6 CFU/ml). Moreover, Oat β-glucan has been reported to selectivity support the growth of lactobacilli and bifidobacteria. In addition, cereals such as oat can be used as fermentable substrates for the growth of probiotic microorganisms (10-Charalampopoulos et al., 2002).

Flow behaviour

The flow behaviour (shear stress/shear rate curves) of different treatments during storage are depicted in figs. 1&2 when fresh and at the end of storage period, respectively. There were significant ($p \leq 0.05$) differences between shear stress values between different treatments depending on type of starter cultures used and different types of cereal's flour used in one side and storage period on the other side. During the investigated time of shearing, the dynamic viscosity values ($p \leq 0.05$) decreased as the shear rate increased in all treatments till the end of storage period. All treatments kept the same shape of the flow curve during storage (results are not shown), exhibited a pseudoplastic shear thinning behaviour.

This shear thinning behavior is due to the progressive breakdown of aggregates formed between milk caseins by the action of the decrease in pH (Fguiri et al., 2012). As it can be seen, treatments containing of oat and hulless barley were characterized with higher dynamic viscosity values during the investigated time of shearing and showed higher upward shifting of the flow curve, as compared with the other treatments containing of triticale and durum wheat either when fresh (Fig.1) or at the end of storage period (Fig. 4). Same finding was reported by Marwa et al., (2015). In addition, Lazaridou and Biliaeri (2007) demonstrated that, β-glucans are major components of starchy endosperm and aleurone cell walls of commercially important cereals such as; oat, barley, rye and durum wheat. These structural features appear to be important determinants of their physical properties such as; water solubility, viscosity and gelation properties. Among all the cereal grains, barely and oat contain the highest level of β-glucan (Charalampopoulos *et al.,*2002). Furthermore, as the storage period advanced the viscosity increased gradually as shown in Fig. (4), due to a strong protein network and firm curd. The same trend in stirred yoghurt was found by Beal *et al.,* (1999).

Table (4): **Viable cell counts (log_{10} CFU[1]/ml) of bacterial starter strains in synbiotic camels' milk like -yogurt during storage.**

Type of starter / bacterial strains	Storage period (days)	Control	Type of cereals			
			Hulless barely	Oats	Triticale	Durum wheat
CH-1						
Lb. bulgaricus	**0**	**7.11^{Eh}±0.08**	**7.84^{Ab}±0.09**	**7.89^{Aa}±0.10**	**7.78^{Bc}±0.08**	**7.75^{Bcd}±0.08**
	3	**7.50^{Cf}±0.07**	**7.89^{Aa}±0.11**	**7.93^{Aa}±0.12**	**7.87^{ABab}±0.11**	**7.81^{Bbc}±0.10**
	6	**7.22^{Dg}±0.05**	**7.83^{Ab}±0.09**	**7.89^{Aa}±0.08**	**7.81^{Abc}±0.10**	**7.76^{ABcd}±0.07**
	9	**6.79^{Fi}±0.04**	**7.63^{Be}±0.07**	**7.71^{Bd}±0.08**	**7.54^{Cf}±0.06**	**7.50^{Cf}±0.06**
Survival (%)		**95.49^{E}±035**	**97.32^{D}±0.38**	**97.72^{A}±0.51**	**96.92^{BC}±0.42**	**96.77^{C}±0.40**
Str. thermophilus	**0**	**7.42^{Fi}±0.06**	**8.87^{ABb}±0.12**	**8.91^{ABab}±0.13**	**8.81^{ABc}±0.10**	**8.74^{ABde}±0.09**
	3	**7.82^{Dg}±0.07**	**8.92^{Aa}±0.13**	**8.98^{Aa}±0.14**	**8.86^{Abc}±0.11**	**8.81^{Acd}±0.10**
	6	**7.64^{Eh}±0.07**	**8.80^{Bcd}±0.09**	**8.83^{Bc}±0.10**	**8.72^{Bde}±0.08**	**8.68^{Be}±0.07**
	9	**7.14^{Gj}±0.06**	**8.68^{Ce}±0.07**	**8.78^{Cd}±0.08**	**8.57^{Cf}±0.06**	**8.49^{Cf}±0.06**
Survival (%)		**96.23^{D}±0.47**	**97.86^{B}±0.51**	**98.54^{A}±0.53**	**97.28^{BC}±0.50**	**97.14^{C}±0.40**
AB-sweet						
Lb. acidophilus	**0**	**6.92^{Fi}±0.03**	**7.78^{ABab}±0.08**	**7.81^{ABa}±0.09**	**7.72A^{Bb}±0.07**	**7.69^{ABbc}±0.06**
	3	**7.30^{Dg}±0.04**	**7.82^{Aa}±0.09**	**7.85^{Aa}±0.10**	**7.78^{Aab}±0.08**	**7.73^{Ab}±0.07**
	6	**7.00^{Eh}±0.03**	**7.71^{Bb}±0.06**	**7.77^{Bb}±0.08**	**7.68^{Bbc}±0.06**	**7.63^{Bcd}±0.05**
	9	**6.51^{Gj}±0.02**	**7.55^{Ce}±0.06**	**7.60^{Cd}±0.06**	**7.47^{Cef}±0.04**	**7.40^{Cf}±0.05**
Survival (%)		**94.08^{D}±0.25**	**97.04^{B}±0.38**	**97.31^{AB}±0.41**	**96.76^{C}±0.35**	**96.23^{C}±0.32**
Bifidobacteria	**0**	**6.$^{90Cf±}$0.02**	**7.72^{Aa}±0.09**	**7.76^{Aa}±0.08**	**7.67^{Bab}±0.09**	**7.63^{Bbc}±0.06**
	3	**6.73^{Cg}±0.03**	**7.70^{Aab}±0.08**	**7.72^{Aa}±0.07**	**7.62^{ABbc}±0.06**	**7.60^{Bbc}±0.05**
	6	**6.54^{Ch}±0.05**	**7.68^{Aab}±0.06**	**7.63^{Ab}c±0.06**	**7.53^{Bcd}±0.07**	**7.58^{AB}c±0.06**
	9	**6.30^{Ci}±0.04**	**7.48^{Ade}±0.06**	**7.53^{Acd}±0.07**	**7.41A^{Be}±0.06**	**7.33^{Be}±0.05**
Survival (%)		**91.30^{E}±0.28**	**96.89^{B}±0.34**	**97.04^{A}±0.36**	**96.61^{C}±0.33**	**96.07^{D}±0.30**

Data represented average of 3 separate trials

[1:]Colony forming unit

A, B,C,…: The means with the different capital (A, B,…) superscript letters within the same raw indicate significant ($P \leq 0.05$) differences between Storage period and Type of cereals

a,b,c,… : Means with the different small (a, b,,,, ,…) superscript letters within the same column and property are significantly ($P \leq 0.05$) different between Type of starter / bacterial strains, Type of cereals and Storage period.

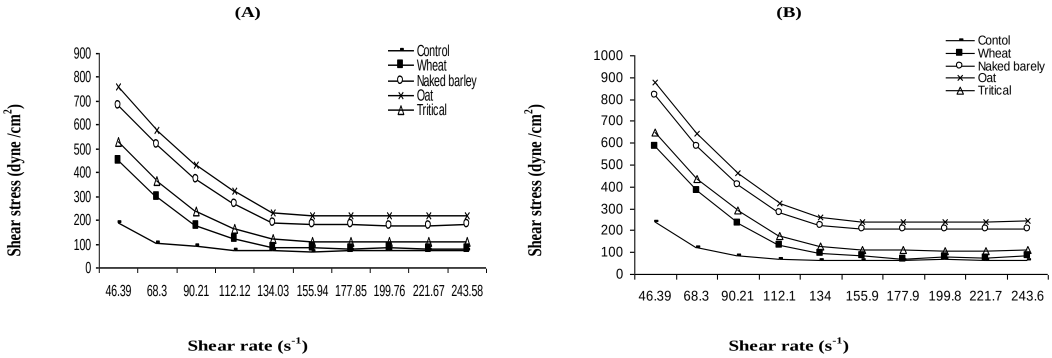

Fig.1. Flow behaviour of fresh synbiotic camels' milk like-yogurt fermented by yoghurt (A) and probiotic (B) starter cultures, respectively.

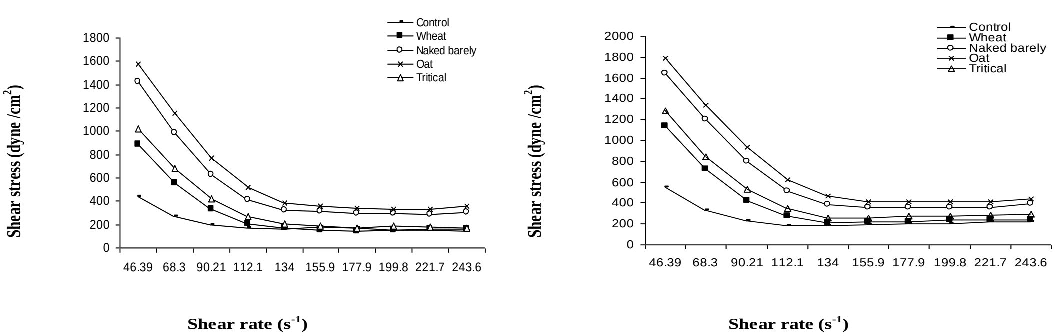

Fig.2. Flow behaviour of synbiotic camels' milk like-yogurt fermented by yoghurt (A) and probiotic (B) starter cultures, respectively during storage period at 6±0.5°C/9 days.

Also, viscosity is correlated with the firmness at constant shear rate, and the viscosity increased with storage time. These results are compatible with Nsabimana et al., (2005). Concerning the type of starter, treatments fermented using yoghurt starter was resulted in the downward shifting of the flow curve as compared with that made by probiotic starter. This decrease in the flow curve indicated that, the dynamic viscosity values of synbiotic camels' milk produced by CH-1culture were considerably less than that made with AB-sweet culture. Our results are in according with Lazaridou & Biliaderis (2007).

Texture characterises

Regarding to data presented in Table 5, significant differences (p≤0.05) were found among treatments, where the type of starter culture or cereal's flour used as well as time of the storage were the principle factors (p≤0.05) influencing on the textural characterises. All textural characterises values of different treatments (except springiness and cohesiveness) increased during storage which may be due to changes and decreasing the pH values and moisture content of during storage. These structural features appear to be important determinants of the physical properties such as; water solubility, viscosity and gelation properties for fermented products (Lazaridou and Biliaeri, 2007). The moisture acts as plasticizer in the protein matrix, thereby making it less elastic and more susceptible to fracture upon compression (Fox et al., 2000). It was noticed that, the hardness were negatively correlated to cohesiveness and springiness for all treatments during storage (Lobato-Calleros et al., 1998). The maximum values of springiness were detected in fresh treatments being the highest values with treatments containing tritical , then these values gradually and significantly (p≤0.05) decreased until the end of storage period, it could be related to the firmness which is correlated to the viscosity (Nsabimana et al., 2005). Meanwhile, the hardness values greatly increased ($P \leq 0.05$) in all treatments during storage period being the highest values with treatments containing oat. This is mainly may be due to the continuous changes in some factors such as decreasing moisture and pH (Awad et al., 2014). As compared between two types of starter used, treatments made with probiotic starter had higher values of hardness, gumminess and chewiness, but lower values of cohesiveness and springiness, as compared with yoghurt starter either when fresh or during storage. Probiotic treatments had higher hardness values; could be due to the ability of polysaccharides to bind significant amount of free water (Awad et al., 2005). These results agreed with sensory evaluation, where yoghurt treatments exhibited whey-free. As it can be seen, treatments containing of oat and barley were characterized with higher hardness values during the investigated time of storage period, as compared with the other treatments containing of durum wheat and triticale. It could be due to that, oat and barely contain the highest level of β-glucan. β-glucans are major components of starchy endosperm and aleurone cell walls of cereals especially, oat,

Table (5): Texture characterizes of synbiotic camels' milk like-yogurt products during storage period.

Storage period (days)	Type of starter culture	Control	Treatments / Textual characterizes			
			Oat	Hulless Barley	Triticale	Durum wheat
Hardness (Newton)						
Fresh	**CH-1**	-	$5.539^{Aa}\pm0.08$	$5.422^{ABab}\pm0.07$	$5.305^{BCbc}\pm0.07$	$5.188^{Cc}\pm0.05$
	AB-sweet	-	$5.664^{Aa}\pm0.08$	$5.570^{Aa}\pm0.06$	$5.454^{Bab}\pm0.06$	$5.361^{Bb}\pm0.06$
3	**CH-1**		$5.799^{Aa}\pm0.09$	$5.686^{ABab}\pm0.08$	$5.499^{BCbc}\pm0.07$	$5.396^{Cc}\pm0.07$
	AB-sweet	-	$5.822^{Aa}\pm0.10$	$5.734^{ABa}\pm0.09$	$5.618^{BCab}\pm0.08$	$5.551^{Cbc}\pm0.06$
6	**CH-1**	-	$6.869^{Aab}\pm0.13$	$6.501^{Ab}\pm0.11$	$5.865^{Bd}\pm0.09$	$5.681^{Bd}\pm0.08$
	AB-sweet	-	$7.422^{Aa}\pm0.13$	$6.855^{Bab}\pm0.12$	$6.452^{BCbc}\pm0.10$	$6.253^{Ccd}\pm0.09$
9	**CH-1**	-	$7.958^{Aa}\pm0.14$	$7.121^{Bbc}\pm0.13$	$6.643^{Ccd}\pm0.12$	$6.223^{Dd}\pm0.11$
	AB-sweet	-	$8.219^{Aa}\pm0.16$	$7.843^{Bab}\pm0.14$	$7.322^{Cb}\pm0.13$	$7.175^{Dbc}\pm12$
Springiness (mm)						
Fresh	**CH-1**	-	$0.566^{Bc}\pm0.02$	$0.570^{Bb}\pm0.02$	$0.574A^{Bab}\pm0.03$	$0.580^{Aa}\pm0.03$
	AB-sweet	-	$0.564^{Bc}\pm0.01$	$0.569A^{Bbc}\pm0.01$	$0.572^{Ab}\pm0.02$	$0.575^{Aab}\pm0.02$
3	**CH-1**	-	$0.554^{Bc}\pm0.01$	$0.558^{Bb}\pm0.02$	$0.565^{ABab}\pm0.04$	$0.570^{Aa}\pm0.03$
	AB-sweet	-	$0.552^{Cc}\pm0.01$	$0.557^{BCbc}\pm0.03$	$0.563^{ABab}\pm0.02$	$0.568^{Aa}\pm0.05$
6	**CH-1**	-	$0.551^{Bb}\pm0.03$	$0.555^{ABab}\pm0.02$	$0.557^{Aa}\pm0.03$	$0.559^{Aa}\pm0.04$
	AB-sweet	-	$0.546^{Bb}\pm0.01$	$0.549^{ABb}\pm0.01$	$0.551^{Ab}\pm0.02$	$0.554^{Aa}\pm0.03$
9	**CH-1**	-	$0.539^{Bc}\pm0.05$	$0.545^{ABb}\pm0.03$	$0.550^{Aa}\pm0.01$	$0.553^{Aa}\pm0.02$
	AB-sweet	-	$0.537^{Bc}\pm0.02$	$0.543^{ABbc}\pm0.02$	$0.548^{Aab}\pm0.03$	$0.551^{Aa}\pm0.03$
Gumminess (Newton)						
Fresh	**CH-1**	-	$2.637^{Aa}\pm0.14$	$2.443^{Bb}\pm0.11$	$2.319^{Cc}\pm0.08$	$2.315^{Cc}\pm0.10$
	AB-sweet	-	$2.668^{Aa}\pm0.13$	$2.490^{Bb}\pm0.12$	$2.356^{Cc}\pm0.09$	$2.341^{Cc}\pm0.10$
3	**CH-1**	-	$2.680^{Ab}\pm0.12$	$2.613^{ABbc}\pm0.10$	$2.559^{BCcd}\pm0.09$	$2.528^{Cd}\pm0.11$
	AB-sweet	-	$2.744^{Aa}\pm0.15$	$2.723^{Aab}\pm0.14$	$2.484^{Bd}\pm0.10$	$2.468^{Bd}\pm0.09$
6	**CH-1**	-	$2.785^{Aa}\pm0.14$	$2.757^{Aab}\pm0.13$	$2.644^{Bb}\pm0.12$	$2.638^{Bb}\pm0.10$
	AB-sweet	-	$2.788^{Aa}\pm0.13$	$2.781^{Aa}\pm0.12$	$2.614^{Bbc}\pm0.10$	$2.545^{Bc}\pm0.08$
9	**CH-1**	-	$2.884^{Aa}\pm0.14$	$2.823^{ABab}\pm0.13$	$2.772^{Bb}\pm0.11$	$2.740^{Bb}\pm0.10$
	AB-sweet	-	$2.912^{Aa}\pm0.15$	$2.833^{Aa}\pm0.14$	$2.673^{Bb}\pm0.12$	$2.585^{Cc}\pm0.09$
Cohesiveness						
Fresh	**CH-1**	-	$0.778^{Bab}\pm0.03$	$0.780^{ABa}\pm0.03$	$0.782^{Aa}\pm0.04$	$0.785^{Aa}\pm0.04$
	AB-sweet	-	$0.775^{ABb}\pm0.02$	$0.773^{Bb}\pm0.02$	$0.777^{Aab}\pm0.03$	$0.779^{Aab}\pm0.04$
3	**CH-1**	-	$0.769^{Bb}\pm0.02$	$0.775^{ABa}\pm0.02$	$0.778^{Aa}\pm0.03$	$0.780^{Aa}\pm0.03$
	AB-sweet	-	$0.762^{Bc}\pm0.03$	$0.766^{ABbc}\pm0.04$	$0.770^{Abc}\pm0.05$	$0.773^{Aab}\pm0.05$
6	**CH-1**	-	$0.757^{Bc}\pm0.02$	$0.768^{ABab}\pm0.03$	$0.772^{Aa}\pm0.03$	$0.776^{Aa}\pm0.04$
	AB-sweet	-	$0.758^{Bc}\pm0.01$	$0.764^{ABbc}\pm0.02$	$0.765^{Aabc}\pm0.04$	$0.768^{Aa}\pm0.04$
9	**CH-1**	-	$0.748^{Cc}\pm0.02$	$0.753^{BCc}\pm0.02$	$0.767^{ABa}\pm0.03$	$0.771^{Aa}\pm0..03$
	AB-sweet	-	$0.753^{Bc}\pm0.01$	$0.760^{ABabc}\pm0.03$	$0.760^{ABabc}\pm0.02$	$0.762^{Aab}\pm0.02$
Chewiness (Newton /mm)						
Fresh	**CH-1**	-	$2.439^{Aa}\pm0.11$	$2.411^{Aab}\pm0.09$	$2.381^{ABb}\pm0.09$	$2.362^{Bb}\pm0.07$
	AB-sweet	-	$2.476^{Aa}\pm0.10$	$2.449^{Aab}\pm0.11$	$2.424^{ABb}\pm0.08$	$2.401^{Bb}\pm0.08$
3	**CH-1**	-	$2.470^{Aa}\pm0.10$	$2.459^{Ba}\pm0.12$	$2.417^{Cc}\pm0.07$	$2.399^{Dc}\pm0.06$
	AB-sweet	-	$2.449^{Aab}\pm0.08$	$2.446^{Ab}\pm0.07$	$2.435^{Bbc}\pm0.06$	$2.437^{Bbc}\pm0.06$
6	**CH-1**	-	$2.865^{Aa}\pm0.13$	$2.770^{Bba}\pm0.11$	$2.522^{Cd}\pm0.10$	$2.464^{De}\pm0.10$
	AB-sweet	-	$3.072^{Aa}\pm0.12$	$2.875^{Ba}\pm0.13$	$2.719^{Cbc}\pm0.11$	$2.660^{Dcd}\pm0.11$
9	**CH-1**	-	$3.208^{Aa}\pm0.13$	$2.975^{Bc}\pm0.12$	$2.802^{Cd}\pm0.12$	$2.653^{De}\pm0.10$
	AB-sweet	-	$3.323^{Aa}\pm0.14$	$3.237^{Bab}\pm0.13$	$3.046^{Cbc}\pm0.12$	$3.0125^{Cbc}\pm0.12$

A, B,C,…: The means with the different capital (A, B,…) superscript letters within the same raw indicate significant (P≤0.05) differences between Type of starter culture and Type of cereals

a,b,c,… : Means with the different small (a, b,,,, ,…) superscript letters within the same column and property are significantly (P≤0.05) different between Type of starter / bacterial strains, Type of cereals and Storage period.

barley, rye. While, Durum wheat is not recognized as a source of β-glucan because of its much lower content, below 1% on a dry basis (Charalampopoulos et al., 2002).

Nutritional and daily values

The results of calculated nutritional and daily values % (vitamins and minerals) of freshly (one day after processing) synbiotic camels' milk products are presented in Tables (6) showed that, all products suggests highly beneficial consumption as a synbiotic products consists of camels' milk with prebiotics (different cereals' flour and honey) and as well as live probiotics since they exceed the minimum target population of probiotics (10^5 to 10^6 g^{-1}) (as shown in Table 4) and could be consider as healthy functional food. FDA, (2004b) defined a healthy food; a food which must be low in fat; contain limited amounts sodium (5% or less) and do not contain ingredients that change the nutritional value. In addition obtaining synbiotic products using adequately selected starter cultures and/or addition of some component (fruits, cereals,…etc) that can increase vitamin level concentrations naturally (Osama et al., 2015). All products had sufficient amounts of vitamins, recommended as a good source of all vitamins studied (Table 6). Also, there were significant differences between treatments either fermented with yoghurt or probiotic starter cultures being the lowest amount with probiotic starters. Same findings were reported by Charalampopoulos et al., (2002). Treatments containing oat flour paste had significantly ($p\leq0.05$) lowest energy, these results matched with the physico- chemical properties (Table 3). Meanwhile, oat treatments characterized with the highest DV % of vitamins especially Thiamin (B1), Ribflavin (B2) and Vitamin E. LeBlanc et al., (2013) reported that, riboflavin concentrations vary in dairy products because of processing technologies and through the action of micro-organisms utilized during food processing. In general, treatments fermented with probiotic strains showed lower amount of vitamins than that fermented with yoghurt starter. Furthermore, all products had high mineral contents and provided significantly higher a good nutritional property of Fe, Mg, P and K values and increased significantly ($p\leq0.05$) in treatments containing oat and barely compared to other treatments. Also, Pandey and Mishra (2015) reported high mineral content and good nutritional properties of synbiotic soy yogurt by determining its calcium and iron contents. Also, food patterns, which were reported to confer longevity included; a high cereal intake (250 g day^{-1}) and a moderate dairy product intake (approximately 300 g milk day^{-1} or equivalent in cheese/yoghurt) (Horwath et al., 1999). All products in this study achieve this food patterns and leading to successful ageing would combine the elements of survival (longevity), health (lack of disability), and life satisfaction (happiness). In conclusion, our investigation provides novel functional foods; beneficial consumption of synbiotic products with varied prebiotics and live probiotics (up to 10^6 CFU g^{-1}). The calculated nutritional and daily values %

showed that all products can be recommended as a good source of calcium and vitamin B1 and considered as healthy food.

Sensory properties

The scores for organoleptic properties (Table 7) showed that significant differences (p≤0.05) were found among treatments, where the type of cereals' flour paste, starter culture used and storage period were the principle factors influencing the sensory properties. It is clear that no marked change occurred in colour and appearance either in fresh or in stored treatments. Also, all treatments characterized by specific taste which is due to the type of cereals' flour used. The resultant products had a good general appearance, body (soft, smooth) and lubricity texture with pleasant creamy flavour. All treatments containing oat rated the highest preference in the scores either when fresh or during storage period and were characterized with perfect flavour, body and texture, as well as appearance and color; especially when fermented with probiotic starter followed by their containing of hulless barely. Meanwhile, treatments containing triticale ranked the lowest in sensory scores. Possible explanation could be due to the pronounced of malt flavour, light dark colour and small amount of free whey; especially when probiotic culture used. The acceptability of probiotic treatments were rated the highest preference and characterized with light sweetie flavour and ropy body and smooth texture than that made with traditional yoghurt starter, probably due to the high sourness, light acidic flavour. Also, no pronounced differences were noticed in appearance of both probiotic and traditional yoghurt samples during the storage. Furthermore, sensory quality decreased (*p*≤0.05) during the refrigeration storage as Akalin (1996). This may be contributed to the high content of several volatile compounds during the fermentation of cereal serve as a precursor of certain flavour compounds, which contribute to a complex blend of flavours in the product. The whey separation in white color appeared to be decreased during storage in all treatments (Table, 7). Vijayalakshmi et al., (2010) mentioned that, during storage of cereal based low fat fruit yoghurt, acidic or malt flavour, firm or ropy body and texture, shrunken or free whey appearance, as well as light brown colour were increased in all treatments at the end of storage. Moreover, the presence of aromas representative of diacetyl, acetic acid and butyric acid make fermented cereal-based products more appetizing. Also, Salmeron et al., (2009) found that, inoculation with the probiotic lactic acid bacteria caused a significant change in the aroma profile of the four cereal broths.

The oat medium showed a significant increment in the contents of flavour active volatiles. In general, the volatile production depends more on the substrate than on the microorganism. Same findings recorded by Blandino et al., (2003).

CONCLUSION

From the forgoing, synbiotic camels' milk like-yogurt products with improved nutritional and

Table (7): Sensory evaluation scores of synbiotic camels' milk like-yogurt products during storage

Type of starter / parameters	Storage period (days)	Control	Type of cereals			
			Hulless barley	Oats	Triticale	Durum wheat
CH-1*						
Flavour (1-10 points)	**0**	$9.5^{Aa}\pm0.19$	$9.4^{Ba}\pm0.19$	$9.6^{Aa}\pm0.20$	$8.8^{Dd}\pm0.15$	$9.2^{Cb}\pm0.18$
	3	$9.2^{Bb}\pm0.16$	$9.1^{Cbc}\pm0.17$	$9.3^{Ab}\pm0.18$	$8.5^{Ee}\pm0.13$	$8.8^{Dd}\pm0.15$
	6	$8.4^{De}\pm0.15$	$8.8^{Bd}\pm0.14$	$9.0^{Ac}\pm0.16$	$8.0^{Ef}\pm0.14$	$8.5^{Ce}\pm0.12$
	9	$8.0^{Df}\pm0.11$	$8.6^{Be}\pm0.11$	$8.8^{Ad}\pm0.13$	$7.8^{Eg}\pm0.08$	$8.1^{Cf}\pm0.11$
Body & Texture (1-5 points)	**0**	$1.5^{Ef}\pm0.03$	$4.5^{Bab}\pm0.09$	$4.7^{Aa}\pm0.10$	$4.0^{Dcd}\pm0.07$	$4.3^{Cbc}\pm0.06$
	3	$1.4^{Ef}\pm0.02$	$4.3^{Bbc}\pm0.07$	$4.5^{Aab}\pm0.08$	$3.8^{Dd}\pm0.04$	$4.1^{Ccd}\pm0.03$
	6	$1.3^{Eg}\pm0.01$	$4.1^{cdB}\pm0.03$	$4.3^{ABbc}\pm0.04$	$3.6^{Dde}\pm0.03$	$3.8^{Cd}\pm0.04$
	9	$1.0^{Eh}\pm0.01$	$3.8^{Bd}\pm0.02$	$4.1^{Acd}\pm0.03$	$3.4^{De}\pm0.03$	$3.6^{Cde}\pm0.05$
Appearance &colour (1-5 points)	**0**	$1.5^{Eh}\pm0.02$	$4.5^{Bb}\pm0.03$	$4.7^{Aa}\pm0.09$	$4.1^{Dd}\pm0.06$	$4.3^{Ccd}\pm0.05$
	3	$1.3^{Ei}\pm0.02$	$4.4^{Bbc}\pm0.09$	$4.6^{Aab}\pm0.08$	$3.8^{Def}\pm0.04$	$4.1^{Cd}\pm0.04$
	6	$1.2^{Ei}\pm0.01$	$4.3^{Bcd}\pm0.08$	$4.5^{Ab}\pm0.07$	$3.6^{Dfg}\pm0.03$	$3.8^{Cef}\pm0.03$
	9	$1.0^{Ej}\pm0.01$	$4.0^{Ce}\pm0.07$	$4.3^{Bcd}\pm0.05$	$3.4^{Bg}\pm0.02$	$3.6^{Afg}\pm0.04$
AB-sweet**						
Flavour (1-10 points)	**0**	$9.6^{Bab}\pm0.16$	$9.6^{Bab}\pm0.17$	$9.8^{Aa}\pm0.18$	$9.1^{Dd}\pm0.14$	$9.4^{Cbc}\pm0.16$
	3	$9.3^{Cbc}\pm0.15$	$9.4^{Bbc}\pm0.15$	$9.6^{Aab}\pm0.17$	$8.8^{Eef}\pm0.12$	$9.1^{Dde}\pm0.15$
	6	$9.0^{Cde}\pm0.13$	$9.2^{Bcd}\pm0.12$	$9.4^{Abc}\pm0.15$	$8.5^{Ef}\pm0.11$	$8.8^{Def}\pm0.13$
	9	$8.5^{Df}\pm0.14$	$9.0^{Bde}\pm0.11$	$9.2^{Acd}\pm0.12$	$8.2^{Eg}\pm0.07$	$8.6^{Cf}\pm0.12$
Body & Texture (1-5 points)	**0**	$1.7^{Eh}\pm0.04$	$4.7^{Bab}\pm0.05$	$4.9^{Aa}\pm0.08$	$4.3^{Dcd}\pm0.05$	$4.5^{Cbc}\pm0.06$
	3	$1.5^{Ei}\pm0.03$	$4.5^{Bbc}\pm0.04$	$4.7^{Aab}\pm0.08$	$4.1^{Dde}\pm0.04$	$4.3^{Ccd}\pm0.05$
	6	$1.3^{Ej}\pm0.02$	$4.3^{Bcd}\pm0.03$	$4.5^{Abc}\pm0.07$	$3.8^{Dfg}\pm0.02$	$4.0^{Cef}\pm0.04$
	9	$1.1^{Ek}\pm0.02$	$4.1^{Bde}\pm0.05$	$4.3A^{cd}\pm0.04$	$3.6^{Dg}\pm0.03$	$3.8^{Cfg}\pm0.03$
Appearance &colour (1-5 points)	**0**	$1.5^{Eh}\pm0.03$	$4.7^{Bab}\pm0.05$	$4.9^{Aa}\pm0.08$	$4.3^{Dde}\pm0.04$	$4.5^{Ccd}\pm0.05$
	3	$1.3^{Ei}\pm0.02$	$4.6^{Bb}\pm0.06$	$4.8^{Aa}\pm0.07$	$4.1^{D}\pm0.03$	$4.3^{Cde}\pm0..04$
	6	$1.2^{Ei}\pm0.01$	$4.4^{Bcde}\pm0.05$	$4.7^{Aab}\pm0.08$	$3.8^{Df}\pm0.02$	$4.1^{Ce}\pm0.03$
	9	$1.0^{Ej}\pm0.01$	$4.2^{Be}\pm0.02$	$4.5^{Acd}\pm0.06$	$3.6^{Dg}\pm0.02$	$3.8^{Cf}\pm0.02$

A, B,C,…: The means with the different capital (A, B,…) superscript letters within the same raw indicate significant ($P\leq0.05$) differences between Type of cereals and storage period.

a,b,c,… : Means with the different small (a, b,,,, ,…) superscript letters within the same column and property are significantly ($P\leq0.05$) different between Type of starter parameters, Type of cereals and Storage period.

functional values, rheological and texture properties, microbiological properties as well as good organoleptic properties could be produced using different cereals' flour (hulless barley, oat, triticale and Durum wheat) either fermented with yoghurt or probiotic starters. All products can be considered as new products from camels' milk with nutritional and functional values as well as good organoleptic properties.

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Table (6): Nutritional and daily values (%) of nutrients, vitamins and minerals in fresh synbiotic camels' milk like-yogurt product

Nutrients	Units count	Type of starter	Values per 100 g									
			Control	DV (%)	Hulless Barley	DV (%)	Oats	DV (%)	Triticale	DV (%)	Durum wheat	DV (%)
Energy	**Kcal**	**CH-1***	**63.07^{De}±0.57**	-	**88.44^{Aa}±0.92**	-	**82.94^{Cd}±0.87**	-	**88.14^{Aa}±0.93**	-	**87.04^{Bb}±0.83**	-
		AB-sweet**	**63.03^{De}±0.55**	-	**88.32^{Aa}±0.91**	-	**82.78^{Dd}±0.85**	-	**87.98^{Bb}±0.82**	-	**86.88^{Cc}±0.82**	-
Protein	**g**	**CH-1***	**3.75^{Cc}±0.02**	**7.50±0.16**	**4.09^{Bb}±0.07**	**8.18±0.17**	**3.64^{Dd}±0.05**	**7.28±0.15**	**4.21^{Aa}±0.08**	**8.42±0.17**	**4.14^{Aab}±0.07**	**8.28±0.19**
		AB-sweet**	**3.73^{Cc}±0.03**	**7.46±0.15**	**4.04^{ABb}±0.06**	**8.08±0.15**	**3.58^{Bc}±0.04**	**7.16±0.13**	**4.14^{Aab}±0.07**	**8.28±0.16**	**4.08^{Ab}±0.06**	**8.16±0.18**
Total fat	**g**	**CH-1***	**3.93^{Aa}±0.02**	**6.05±0.14**	**1.88^{BCbc}±0.03**	**2.89±0.03**	**1.74^{Cc}±0.03**	**2.677±0.04**	**1.98^{Bb}±0.02**	**3.046±0.05**	**1.92^{Bb}±0.03**	**2.954±0.03**
		AB-sweet**	**3.93^{Aa}±0.04**	**6.05±0.11**	**1.88A^{Cbc}±0.02**	**2.89±0.03**	**1.74^{Cc}±0.03**	**2.677±0.03**	**1.98^{Bb}±0.02**	**3.046±0.04**	**1.92^{Bb}±0.03**	**2.954±0.02**
Total carbohydrate	**g**	**CH-1***	**4.39^{Cc}±0.03**	**1.46±0.01**	**13.79^{Aa}±0.15**	**4.59±0.05**	**13.18^{Bc}±0.14**	**4.393±0.06**	**13.37^{ABab}±0.14**	**4.457±0.08**	**13.30^{ABab}±0.12**	**4.433±0.06**
		AB-sweet**	**4.40^{Cc}±0.03**	**1.47±0.01**	**13.81^{Aa}±0.14**	**4.60±0.06**	**13.20^{Bc}±0.13**	**4.400±0.05**	**13.40^{ABab}±0.14**	**4.467±0.09**	**13.32^{Bbc}±0.13**	**4.440±0.05**
Vitamins and minerals												
Thiamin (B1)	**mg**	**CH-1***	**0.012^{Ce}±0.001**	**0.80±0.01**	**0.314^{Aa}±0.05**	**20.933±0.24**	**0.354^{Aa}±0.06**	**23.60±0.27**	**0.239^{Bcd}±0.05**	**15.933±0.21**	**0.254^{Bbc}±0.04**	**16.933±0.18**
		AB-sweet**	**0.012^{Ce}±0.002**	**0.80±0.01**	**0.295^{Ab}±0.03**	**19.667±0.20**	**0.323^{Aab}±0.05**	**21.53±0.23**	**0.218^{Bd}±0.06**	**14.533±0.20**	**0.233^{Bcd}±0.03**	**15.533±0.16**
Ribflavin (B2)	**mg**	**CH-1***	**0.019^{De}±0.001**	**1.12±0.01**	**0.132^{Bab}±0.02**	**7.765±0.16**	**0.152^{Aa}±0.03**	**8.94±0.16**	**0.125^{Cbc}±0.02**	**7.353±0.15**	**0.128^{BCb}±0.02**	**7.529±0.12**
		AB-sweet**	**0.018^{De}±0.002**	**1.06±0.01**	**0.128^{Bb}±0.02**	**7.529±0.17**	**0.147^{Aa}±0.02**	**8.65±0.17**	**0.115^{Cd}±0.01**	**6.765±0.13**	**0.119^{Ccd}±0.02**	**7.000±0.11**
Vitamin (B6)	**mg**	**CH-1***	**0.025^{De}±0.003**	**1.25±0.02**	**0.038^{ABa}±0.004**	**1.90±0.02**	**0.040^{Aa}±0.002**	**2.00±0.05**	**0.029^{Cbc}±0.001**	**1.45±0.01**	**0.032^{BCb}±0.002**	**1.60±0.02**
		AB-sweet**	**0.024^{De}±0.003**	**1.20±0.01**	**0.035^{ABab}±0.003**	**1.75±0.02**	**0.037^{Aa}±0.002**	**1.85±0.06**	**0.025^{Cc}±0.001**	**1.25±0.02**	**0.029^{BCbc}±0.001**	**1.45±0.03**
Vitamin A	**Iu**	**CH-1***	**20.05^{Cc}±0.24**	**0.40±0.01**	**21.88^{Bb}±0.26**	**0.438±0.01**	**23.25^{Aa}±0.27**	**0.465±0.02**	**21.18^{Bb}±0.18**	**0.424±0.03**	**21.34^{Bb}±0.15**	**0.427±0.03**
		AB-sweet**	**20.03^{Cc}±0.22**	**0.40±0.01**	**21.82^{Bb}±0.24**	**0.436±0.01**	**23.21^{Aa}±0.28**	**0.464±0.02**	**21.12^{Bb}±0.17**	**0.422±0.03**	**21.28^{Bb}±0.16**	**0.426±003**
Vitamin E	**Iu**	**CH-1***	**0.145^{Aa}±0.01**	**0.48±0.01**	**0.069^{Cc}±0.005**	**0.230±0.03**	**0.077^{Bb}±0.006**	**0.257±0.01**	**0.066^{Cc}±0.004**	**0.220±0.02**	**0.068^{Cc}±0.005**	**0.227±0.02**
		AB-sweet**	**0.142^{Aa}±0.01**	**0.47±0.01**	**0.065^{Cc}±0.006**	**0.217±0.02**	**0.072^{Bb}±0.005**	**0.240±0.02**	**0.061^{Cc}±0.003**	**0.203±0.02**	**0.064^{Cc}±0.004**	**0.213±0.01**
Calcium (Ca)	**mg**	**CH-1***	**58.44^{Df}±0.24**	**5.844±0.03**	**106.251^{Bc}±1.62**	**10.625±0.23**	**109.884^{Aa}±0.56**	**10.988±0.18**	**103.753^{Cd}±0.53**	**10.375±0.16**	**103.453^{Cd}±1.09**	**10.345±0.14**
		AB-sweet**	**58.41^{Df}±0.26**	**5.841±0.02**	**105.432^{Bc}±1.57**	**10.543±0.21**	**108.441^{Ab}±0.54**	**10.844±0.17**	**102.550^{Ce}±0.48**	**10.255±0.17**	**102.224^{Ce}±1.06**	**10.222±0.16**
Phosphorus (p)	**mg**	**CH-1***	**42.28^{Eg}±0.31**	**4.228±0.02**	**62.700^{Bc}±1.15**	**6.27±0.14**	**65.356^{Aa}±0.38**	**6.536±0.13**	**59.334^{Ce}±0.32**	**5.933±0.12**	**58.556^{Df}±0.94**	**5.856±0.12**
		AB-sweet**	**41.52^{Eg}±0.36**	**4.452±0.02**	**61.250^{Bd}±1.09**	**6.125±0.15**	**64.332^{Ab}±0.37**	**6.433±0.12**	**59.119^{Ce}±0.30**	**5.912±0.14**	**58.321^{Df}±0.91**	**5.832±0.11**
Potassium (K)	**mg**	**CH-1***	**80.05^{Eg}±0.45**	**2.290±0.01**	**112.04^{Bc}±1.60**	**3.206±0.06**	**114.55^{Aa}±0.63**	**3.278±0.04**	**110.34^{Ce}±0.57**	**3.157±0.09**	**108.75^{Df}±1.04**	**3.112±0.06**
		AB-sweet**	**79.56^{Eg}±0.42**	**2.276±0.02**	**111.45^{Bd}±1.40**	**3.189±0.05**	**113.69^{Ab}±0.62**	**3.253±0.06**	**110.20^{Ce}±0.51**	**3.153±0.08**	**107.88^{Dg}±1.08**	**3.087±0.07**
Magnesium (Mg)	**mg**	**CH-1***	**9.80^{Dd}±0.14**	**2.450±0.03**	**19.234^{Bb}±0.22**	**4.809±0.08**	**21.663^{Aa}±0.28**	**5.418±0.10**	**18.703^{Cc}±0.24**	**4. 676±0.10**	**18.552^{Cc}±0.21**	**4.638±0.08**
		AB-sweet**	**9.85^{Dd}±0.11**	**2.463±0.02**	**19.182^{Bb}±0.27**	**4.796±0.07**	**21.244^{Aa}±0.25**	**5.311±0.09**	**18.552^{Cc}±0.22**	**4.638±0.09**	**18.482^{Cc}±0.20**	**4.621±0.09**
Sodium (Na)	**mg**	**CH-1***	**24.22^{Cc}±0.17**	**1.011±0.01**	**29.066^{Bb}±0.18**	**1.214±0.01**	**27.214^{Cc}±0.12**	**1.136±0.02**	**30.352^{Aa}±0.19**	**1.267±0.01**	**30.213^{Aa}±0.21**	**1.261±0.02**
		AB-sweet**	**24.17^{Cc}±0.16**	**1.009±0.01**	**29.037^{Bb}±0.19**	**1.212±0.01**	**27.185^{Cc}±0.14**	**1.135±0.02**	**30.324^{Aa}±0.20**	**1.266±0.02**	**30.177^{Aa}±0.20**	**1.260±0.02**
Iron (Fe)	**mg**	**CH-1***	**1.12Aa±0.10**	**5.97±0.09**	**0.244^{Bc}±0.02**	**1.301±0.02**	**0.249^{Bc}±0.03**	**1.328±0.02**	**0.241^{Cd}±0.02**	**1.285±0.01**	**0.240^{Cd}±0.01**	**1.280±0.03**
		AB-sweet**	**1.06Ab±0.08**	**5.65±0.08**	**0.206^{Df}±0.03**	**1.099±0.01**	**0.229^{Bd}±0.05**	**1.221±0.01**	**0.221^{Be}±0.02**	**1.179±0.01**	**0.220^{Ce}±0.02**	**1.173±0.02**

A, B,C,…: The means with the different capital (A, B,…) superscript letters within the same raw indicate significant (P≤0.05) differences between Type of starter culture.

a,b,c,… : Means with the different small (a, b,,,, ,…) superscript letters within the same column and property are significantly (P≤0.05) different between Type of starter / bacterial strains and Type of cereal