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Production of Probiotic Stirred Yoghurt from Camel Milk and Oat Milk

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ABSTRACT

The effect of partial replacement of camel's milk with Oat milk on the physicochemical, rheological, microbiological, antioxidant and sensory properties of probiotic stirred camel milk yoghurt during storage was investigated. Stirred yoghurt was made from camel milk served as a control, and the other treatments were made from camel milk after replacing 10, 20, 30 and 40% of it by Oat milk. Resultant stirred yoghurt of other treatments were analyzed after1, 5 and 10 day of storage at 4 ± 1˚C for physicochemical, microbiological, antioxidant and sensory properties Results revealed that partial replacement of camel's milk with Oat milk were more effective in increasing the total solids, protein, ash, total carbohydrates, acidity and total volatile fatty acid (TVFA), viscosity, phenolic content and antioxidant activity and these increments were proportional to the replacement ratio. Partial replacement of camel's milk with Oat milk enhanced the viability of *Streptococcus thermophiles, Lactobacillus acidophilus* and *Bifidobacterium bifidum* and this enhancement was proportional to the replacement ratio . Probiotic camel milk stirred yoghurt containing 40 % Oat milk had the highest scores for sensory properties compared to other probiotic camel milk stirred yoghurt treatments .Thus, The study concluded that camel milk could be replaced with Oat milk until 40 % as a source of bioactive components and dietary fiber in manufacture of probiotic camel stirred milk yoghurt, this replacement up to 40% improved the physicochemical, rheological, microbiological antioxidant and sensory properties of resultant yoghurt.

***Keywords*:** probiotic, Oat milk, camel milk yoghurt, physicochemical, microbiological, sensory properties

INTRODUCTION

Camel milk is a healthy food used in many countries across the world for different health problems since long years. Fermented camel milk is proved to have some health benefits, proved or not, such as hypocholesterolaemic effect, antimicrobial activity, antioxidant activity, angiotensin I-converting enzyme (ACE) inhibitory activity, activity against diarrhea, anticancer activity. (Solanki and Hati, 2018).

Camels are a major source of milk and meat in the Middle East. Camel milk is the most consumed milk in the Arab Gulf countries as a whole. Camel milk is characterized than cow's milk where it has a high nutritional and health value because it contains immune proteins such as lysozyme, which is an antioxidant and anti-inflammatory, aminoglobulins, with no beta-lactoglobulin which may cause allergic reactions to some people, and contains a large amount of Vitamin C, iron, potassium and vitamin E, A (Salem *et al*., 2017; Khalesi *et al*., 2017).

Camel milk contains, low casein content, a very low ratio of beta-casein to kappa- casein, low percent of α - s casein, contains greater amounts of whey protein and antimicrobial components such as lysozyme, lactoferrin and immunoglobulin's than bovine or buffalo milk (Agrawal *et al*., (2007).All these factors influence the technological properties of the heat treatment and acid or enzymatic coagulation of camel's milk (so it is almost semi liquid).(Omar *et al* ,2019).

Yoghurt is produced by fermentation of milk using lactic acid bacteria culture contain *Streptococcus salivarius ssp. thermophilus and Lactobacillus delbrueckii ssp. Bulgaricus*. The rheological and sensory properties of yoghurt are influenced with some factors such as milk base, starter culture and processing conditions (Pakseresht *et al*, 2019).

Increased attention has been given to improving fermented dairy products containing probiotic bacteria because of their health benefits (Oliveira *et al*., 2002). Dairy products containing probiotics have spread in many countries around the world (Tharmaraj & Shah, 2003) to obtain a dietetic therapeutic effect that reduces the symptoms associated with high cholesterol (Walsh *et al*., 2010).

Therefore, one of the most important step in the production of camel yoghurts is the increase of its total solids content to optimize the viscosity and improve the body and texture (Omar *et al*,2019).Some researchers have reported that addition of gelatin increased viscosity and firmness, prevented syneresis, and improved the sensory attributes of yogurt (Kumar and Mishra, 2004; Ares *et al*., 2007; Supavititpatana *et al*., 2008).Also ,addition of whey protein concentrate enhanced the textural properties of yogurt made from goat milk. Yogurt fortified with calcium was produced without affecting its microbiological, sensory, and rheological characteristics (Herrero and Requena 2006, Singh and Muthukumarappan, 2008).

Cereals and their components have been accepted as a functional food due to its provision of antioxidants ,vitamins dietary fiber, protein, energy, and minerals required for human health. Also, cereals can be used as fermentable substances for the growth of probiotic bacteria (Charalampopoulos *et al*, 2002).

Oat (*Avena sativa* L.) and oat products are a good sources of vitamin E, polyunsaturated fatty acids ,soluble dietary fiber, β-glucan, and their consumption in the human diet is beneficial to human well-being (Singh *et al*. 2011: Tiwari and Cummins 2012).

Using some probiotic strains such as *L. acidophilus* and *Bifidobacterium spp*., for fermenting the vegetarian milk, also fortification the vegetarian milk with a source of protein may be enhance the functional properties of final product compared to

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traditional fermented vegetarian milk made with yoghurt culture without any fortification (El-Batawy *et al* ,2019).

Therefore, the aim of this study was to produce stirred bio-yoghurt from camel milk after partially replacement part of this milk with Oat milk. Studying the effect of this replacement on the chemical, microbiological, rheological, antioxidant and sensory properties of the resultant product during cold storage was also a goal of the study.

MATERIALS AND METHODS

Materials:

Camel milk was obtained from Desert Research Center, Dokki, Egypt. Dried whey protein concentrate (DWPC) was purchased from Mullins Whey Company, USA origin. Oat flakes purchased from local market. Food grade "-amylase from *Bacillus subtilis* was purchased from Sigma Aldrich which had an activity of 2000IU in a powder form , other chemicals and reagents were purchased form Sigma-Aldrich .

ABT-5 culture containing *Streptococcus thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium bifidum* were obtained from the Microbiological Resources Center (MIRCEN), Faculty of Agric. Aim Shams Univ., Egypt.

Methods:

Preparation of oat milk:

Oat milk was prepared according to enzymatic method described by Deswal *et al*, (2014) About 1 kg of rolled oats was ground into a laboratory food processor to produce finely granulated oat flour and then mixed with 2.7 kg of water. Calcium chloride at a concentration of 0.04% (w/w) was added as a catalyst for the enzyme. Oat slurry was treated with "-amylase (77.78 mg kgG1 of Rolled oats) for liquefaction for 49 min at 75 ˚C. The liquefied oat solids were then filtered through muslin cloth to get the Oat milk. At the end of the treatment, the enzyme was inactivated by heating at 100 ˚C for 5 min.

Probiotic Fermented Camel Milk Preparation:

Probiotic fermented camel's milk was manufactured according to the method reported by Tamime and Robinson, (1999) and modified with Hashim *et al*,(2009).The product was prepared from 5 treatments as follows:

Whole camel milk as a control (C)
Whole camel milk was replaced with 10% Oat milk (T1)
Whole camel milk was replaced with 20% Oat milk (T2)
Whole camel milk was replaced with 30 % Oat milk (T3)
Whole camel milk was replaced with 40 % Oat milk (T4)

Milk of all treatments were fortified with 2 % dried whey protein concentrate (DWPC) , homogenized at 55–60°C for 2 min using a high speed mixer (22,000 rpm/min), heat-treated in a thermostatically controlled water bath at 85 °C for 30 min ,cooled to 42°C in an ice bath, ,inoculated with 5 % (w/v) ABT5 culture, incubated at 42ºC for 6–8 h until a firm curd was obtained, the curd was refrigerated at 4°C overnight and stirred using the mixer , stored at 4 ± 1 °C, for 10 days, and then analyzed after 1, 5 and 10 days of storage for physicochemical, rheological , microbiological, and sensory properties. This experiment was repeated 3 times.

Methods of Analysis:

Determination of Chemical Composition:

The dry matter, protein, fat, ash contents and titratable acidity (expressed as lactic acid %) were determined as described in AOAC (2007). The pH values were measured by digital laboratory pH meter (HANNA Digital). Total volatile free fatty acids Kosikowski, (1982). Carbohydrate content Ceirwyn, (1995), uses the following formula:

Total carbohydrates% = 100 – (%fat + %protein + %ash + %fiber +%moisture).

Rheological analysis:

Viscosity was determined according to Aryana (2003).

Determination of total phenolic content:

The total phenolic content (TPC) of treatments were determined by Folin-Ciocalteu assay using Gallic acid as the standard according to Kaur and Kapoor (2002) .The total phenolic content was expressed as gallic acid equivalents (mg GAE/100g dry weight basis) through the calibration curve of Gallic acid.

Radical scavenging activity (Scavenging DPPH):

The antioxidant activity was evaluated by the DPPH assay according to Brand Williams *et al*, (1995). The scavenging activity percentage (AOA %) was determined according to Mensor *et al*,(2001) as follows:

$$AOA(\%) = 1 - Abs_{sample} \_ Abs_{blank} / Abs_{control} \times 100 \quad (1)$$

Microbiological analysis:

Differential media used for enumeration of *S. thermophilus*, *L. acidophilus* and *Bifidobacterium BB*-12 where those previously described by Martin-Diana *et al.* (2003).Total bacterial count was determined according to Houghtby *et al*., (1992).

Sensory evaluation:

The sensory properties of yoghurt samples were assessed by 10 panel members of the Dairy Sci., Dep., Fac. Agric., Zagazig, Univ. for flavour (60) body and texture (30) and appearance (10) as reported according to Nelson and Trout (1981).

Statistical analysis:

The obtained results were evaluated statistically using analysis of variance as reported by McClave & Benson (1991). In addition the other reported values were expressed as mean ±SD and ±SE, two – tailed Student's t test was used to compare between different groups. P value less than 0.05 was considered statistically significant. SPSS (Chicago, IL, USA) software window Version 16 was used.

RESULTS AND DISCUSSION

Chemical composition of fresh camel milk, Oat milk and dried whey protein concentrate:

The chemical composition of fresh camel milk, Oat milk and dried whey protein concentrate are illustrated in Table (1). Total solids, protein, fat, ash carbohydrate and fiber contents of camel milk were 12.58, 3.18, 4.12, 0.82, 4, 46 and 0.0 g/100g, respectively. These results are in agreement with the data obtained by Rahli *et al* ,(2013) and Omar *et al*., (2019).Total solids, protein, fat, ash carbohydrate and fiber contents of Oat milk were (21.70, 2.30, 1.74, 0.354, 17, 30 and 2.04 g/100g) respectively. These results are in agreement with the data obtained by Singhal *et al*, (2017) and El-Batawy *et al*., (2019). While, total solids, protein, fat, ash carbohydrate and fiber contents of dried whey protein concentrate were (95.40, 87.36, 0.10, 2.62, 5, 32 and 0.0 g/100g) respectively. These results are in agreement with the data obtained by Frederico *et al*, (2016) and El-Batawy *et al*., (2019).

Table 1. Chemical composition of fresh camel milk, Oat milk and dried whey protein concentrate

Components (%)	Camel milk	Oat milk	Dried whey protein concentrate
Total Solids	12.58±0.25	21.70±0.80	95.40±1.2
Protein	3.18±0.08	2.30±0.06	87.36±1.04
Fat	4.12±0.04	1.74±0.02	0.10±0.01
Ash	0.82±0.01	0.354±0.01	2.62±0.02
Total carbohydrate	4.46±0.06	17.30±0.60	5.32±0.15
Fiber	----	2.04±0.04	-----

Chemical composition of probiotic camel milk stirred yoghurt containing Oat milk:

From results presented in Table (2) ,it could be seem that, that control probiotic camel milk yoghurt had the lowest total solids (TS), protein, ash ,fiber and carbohydrate contents it was

significantly ($P \leq 0.05$) compared with yoghurt made from camel milk with partially replacement with Oat milk treatments. The TS, protein, ash, fiber and carbohydrate contents of yoghurt made from camel milk with partially replacement with Oat milk increased gradually by increasing the replacement ratio ,this may be due to a high TS, protein, ash, fiber and carbohydrate contents of Oat milk compared with camel milk (Singhal *et al*, 2017) and El-Batawy *et al*., 2019). Concerning fat content, partial replacement of camel milk with Oat milk did not affect the fat content of resultant yoghurt. The TS, protein, ash, fat, and fiber contents of all treatments increased as storage period progressed, while carbohydrate content decreased, this may be due to the evaporation of water or loss of moisture content during storage (Hassan and Ismran, (2010). These results are in agreement with those reported by Omar *et al*., (2019), they found that partial replacement of camel milk with skim milk retentate increased the TS, protein, ash and carbohydrate contents of resultant bio-yoghurt compared with bio-yoghurt mad from camel milk. Also, Hasani *et al*., (2017), they found that the addition of barley bran to yoghurt increased the TS, protein, ash and carbohydrate contents of resultant yoghurt.

Table 2. Chemical composition of probiotic camel milk stirred yoghurt containing Oat milk during storage at refrigerator temperature for 10 day

Components (%)	Storage period (day)	Treatments				
		C	T_1	T_2	T_3	T_4
Total Solids	1	14.54±0.50^{e}	16.20±0.42^{d}	18.34±0.64^{c}	19.48±0.58^{b}	21.72±0.44^{a}
	5	15.02±0.42^{e}	16.72±0.40^{d}	18.80±0.52^{c}	20.04±0.60^{b}	22.20±0.50^{a}
	10	15.62±0.40^{e}	17.20±0.44^{d}	19.32±0.58^{c}	20.52±0.50^{b}	22.82±0.62^{a}
Protein	1	5.20±0.18^{e}	5.42±0.24^{d}	5.70±0. 20^{c}	6.02±0. 26^{b}	6.28±0.22^{a}
	5	5.62±0.28^{e}	5.88±0.26^{d}	6.14±0.32^{c}	6.50±0.24^{b}	6.82±0.30^{a}
	10	6.04±0.22^{e}	6.32±0.28d	6.58±0.30c	7.04±0.34^{b}	7.30±0.22a
Fat	1	4.22±0.16^{a}	3.94±0.18^{b}	3.62±0.12^{c}	3.30±0.18^{d}	3.02±0.16^{e}
	5	4.36±0.12^{a}	4.06±0.22^{b}	4.75±0.18^{c}	3.43±0.22^{d}	3.18±0.20^{e}
	10	4.60±0.14^{a}	4.20±0.16^{b}	4.88±0.20^{c}	3.56±0.14^{d}	3.32. ±0.18^{e}
Ash	1	0.92±0.09^{e}	1.10±0.07^{d}	1.42±0.10^{c}	1.70±0.08^{b}	2.04±0.05^{a}
	5	0.95±0.07^{e}	1.16±0.10^{d}	1.48±0.08^{c}	1.77±0.05^{b}	2.12±0.07^{a}
	10	1.02±0.05^{e}	1.24±0.07^{d}	1.54±0.06^{c}	1.84±0.09^{b}	2.18±0.06^{a}
Carbohydrate	1	4.20±0.18^{e}	6.24±0.12^{d}	8.10±0.14^{c}	9.00±0.22^{b}	10.84±0.28^{a}
	5	4.09±0.14^{e}	6.12±0.18^{d}	6.93±0.12^{c}	8.84±0.20^{b}	10.58±0.22^{a}
	10	3.96±0.12^{e}	5.94±0.16^{d}	6.82±0.15^{c}	8.58±0.24^{b}	10.47±0.20^{a}
Fiber	1	---	0.52±0.02^{d}	1.06±0.04^{c}	1.52±0.02^{b}	1.64±0.04^{a}
	5	---	0.56±0.01^{d}	1.10±0.08^{c}	1.55±0.05^{b}	1.70±0.06^{a}
	10	---	0.60±0.04^{d}	1.16±0.06^{c}	1.62±0.04^{b}	1.74±0.08^{a}

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**
C: Probiotic stirred yoghurt made from camel milk as a control (C) .
T_1: Probiotic stirred yoghurt made from camel milk with partially replacement with 10% Oat milk
T_2: : Probiotic stirred yoghurt made from camel milk with partially replacement with 20% Oat milk
T_3: : Probiotic stirred yoghurt made from camel milk with partially replacement with 30% Oat milk
T_4: : Probiotic stirred yoghurt made from camel milk with partially replacement with 40% Oat milk

Titratable acidity, pH values and total volatile fatty acids of probiotic camel milk stirred yoghurt containing Oat milk:

Table, (3) indicated that titratable acidity (TA) of the control camel milk yoghurt showed the lowest value during storage , this may be due to a high antimicrobial components such as lysozyme, lactoferrin and immunoglobulin's in camel milk which decreased viability of starter culture(Omer, and Eltinay, 2008, Quan *et al* ,2008 : Galeboe *et al* ,2018). The acidity of yoghurt made from camel milk with partially replacement with Oat milk increased gradually by increasing the replacement ratio, this may be due to contains Oat milk fermentable substance which improved viability of starter culture (Singhal *et al*, 2017 and El-Batawy *et al*., 2019).. TA of all treatments increased gradually as the storage period advanced. pH values of all treatments behaved reverse trend to TA, during storage. Similar results were obtained by Omar *et al*, (20119) they found that partial replacement of camel milk with skim milk retentate increased the TA and decreased pH values of resultant bio-yoghurt compared with bio-yoghurt mad from camel milk.

Concerning total volatile fatty acids (TVFA),it could be noticed that TVFA content were gradually increased in all probiotic yoghurt samples as storage period progressed. The rate of increase in TVFA was found higher in all treatments than in control. The TVFA content of yoghurt made from camel milk with partially replacement with Oat milk increased gradually by increasing the replacement ratio. This may be due to the presence of some growth factors in Oat milk which enhancing and increasing the starter activity (Deswal *et al*, 2014 and and El-Batawy *et al*., 2019). The TVFA content of all yoghurt treatments increased as storage period progressed, these results might be due to the proteolytic and lipolytic activities of the starter culture during making and storage of the product (Mehanna, *et al*., 2000).. Similar results were obtained by Omar *et al*, (20119).

Values of viscosity, of all treatments, were gradually increased during the storage period as the percentage of Oat milk increased. Viscosity of the control treatment (C), was the lowest value, while replacement of camel milk with Oat milk greatly increased of viscosity, along the storage period. Similar results were reported by Akalin *et al*., (2007) and Omar *et al*, (2019) they observed that increasing the total solid in milk caused an increase in the density, lead to a reduction in the syneresis and improved the viscosity of the yoghurt gel. Also, Al-Zoreky and Al-Otaibi (2015), found that addition of stabilizers (CMC, pectin, gum acacia, or alginate) at 0.6% improved the texture and rheological of camel milk yogurt.

Total phenolic content and antioxidant activity of probiotic camel milk stirred yoghurt containing Oat milk:

Total phenolic content and radical scavenging activity probiotic stirred camel milk yoghurt made from camel milk with partially replacement with Oat milk are presented in Table (4): Total phenolic content of probiotic stirred camel milk yoghurt supplemented with Oat milk were increased by increasing the replacement ratio compared to control probiotic stirred camel milk yoghurt ,this may be due to a higher total phenolic content of Oat milk (Ibrahim *et al* ,2020) than camel milk (Soliman, and Shehata, 2019). The TPC and RSA% of all yoghurt treatments

increased as storage period progressed until 10 days. These results are in agreement with those reported by Ibrahim *et al*, (2020) who found that total phenolic content and radical scavenging activity of fermented camel's milk increased when fortified camel milk with different ratios of kiwi and avocado. Also, Atwaa and Elmaadawy (2019) found that addition of garden cress seed powder to low fat yoghurt increased the total phenolic content and radical scavenging activity of low fat yogurt.

Table 3. Titratable acidity, pH values, viscosity and total volatile fatty acids of probiotic camel milk stirred yoghurt containing Oat milk during storage at refrigerator temperature for 10 day

Parameters	Storage period (Day)	Treatments				
		C	T_1	T_2	T_3	T_4
Acidity%	1	0.75±0.01^{d}	0.79±0.05^{c}	0.83±0.04^{bc}	0.87±0.02^{b}	0.92±0.06^{a}
	5	0.82±0.04^{d}	0.85±0.03b^{c}	0.88±0.02^{c}	0.92±0.06^{b}	0.99±0.03^{a}
	10	0.88±0.03^{e}	0.92±0.02^{d}	0.96±0.05^{c}	1.00±0.04^{b}	1.12±0.05^{a}
pH values	1	4.82 ±0.07^{a}	4.78 ±0.04^{ab}	4.72 ±0.10^{b}	4.68 ±0.06^{bc}	4.64 ±0.08^{c}
	5	4.70 ±0.06^{a}	4.66 ±0.10^{ab}	4.60 ±0.08^{b}	4.56 ±0.09^{bc}	4.50 ±0.10^{c}
	10	4.68 ±0.10^{a}	4.58 ±0.09^{ab}	4.56 ±0.04^{b}	4.48 ±0.05^{bc}	4.42 ±0.07^{c}
TVFA (ml N0.1 NaOH/100g)	1	7.2±0.42^{e}	7.8±0.46^{d}	8.4±0.44^{c}	8.9±0.40^{b}	9.4±0.42^{a}
	5	7.9±0.36^{e}	8.6±0.30^{d}	9.3±0.38^{c}	9.6±0.32^{b}	10.2±0.34^{a}
	10	8.7±0.24^{e}	9.5±0.22^{d}	10.2±0.26^{c}	10.5±0.20^{b}	10.9±0.28^{a}
Viscosity (C.P.S.)	1	2120±94.0^{e}	2270±90.0^{d}	2310±96.0^{c}	2380±92.0^{b}	2430±90.0^{a}
	5	2180±72.0^{e}	2350±75.0^{d}	2370±70.0^{c}	2420±74.0^{b}	2460±72.0^{a}
	10	2230±58.0^{e}	2390±52.0^{d}	2420±54.0^{c}	2470±50.0^{b}	2510±56.0^{a}

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**

Table 4. Total phenolic content and antioxidant activity of probiotic camel milk stirred yoghurt containing Oat milk during storage at refrigerator temperature for 15 day.

Parameters	Treatments	Storage period (days)		
		1	5	10
Total phenolic content (mg / g)	C	1.48. ±0.06^{e}	1.60±0.12^{e}	1.74 ±0.14^{e}
	T1	1.92±0.11^{d}	2.04±0.16^{d}	2.10±0.11^{d}
	T2	2.30±0.18^{c}	2.48±0.11^{c}	2.56±0.12^{c}
	T3	2.78±0.12^{b}	2.96±0.18^{b}	3.12±0.18^{b}
	T4	3.06±0.09^{a}	3.22±0.14^{a}	3.58±0.22^{a}
Radical scavenging activity RSA %	C	8.42±0.35^{e}	17.26±0.40^{e}	20.62±0.46^{e}
	T1	9.70±0.42^{d}	18.50±1.12^{d}	21.70±0.65^{d}
	T2	10.96±0.33^{c}	20.04±1.08^{c}	23.08±0.77^{c}
	T3	12.14±0.52^{b}	21.90±0.96^{b}	24.32±0.68^{b}
	T4	13.36±0.60^{a}	23.20±1.02^{a}	26.18±0.42^{a}

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**

Microbiological properties of probiotic camel milk stirred yoghurt containing Oat milk:

The viability of *Streptococcus thermophiles, Lactobacillus acidophilus and Bifidobacterium. bifidum* starter cultures, of control and fortified probiotic camel yoghurts during storage period at (4 ±1°C) was shown in Table 5. The results indicated that, *Streptococcus thermophiles, Lactobacillus acidophilus and Bifidobacterium. bifidum* counts reached its maximum increment during the 5 days and then declined slightly in all yoghurts until the end of storage period, these may be due to the death of the viable flora via H_2O_2 produced by the starter bacteria, oxygen content, pH value, storage environment and concentration of metabolites such as lactic acid (Akalin *et al*. 2007). Control camel milk yoghurt had the lowest *Streptococcus thermophiles, Lactobacillus acidophilus and Bifidobacterium. Bifidum* counts owing to the presence of growth inhibiting factors, especially lysozyme, in camel milk. Yoghurt treatments fortified with Oat milk had the highest *Streptococcus thermophiles, Lactobacillus acidophilus and Bifidobacterium. bifidum* counts, which increased with increasing the replacement ratio.

The addition of Oat milk improved the viability of *Streptococcus thermophiles, Lactobacillus acidophilus and Bifidobacterium bifidum* ,this may be due to the presence of some growth factors in Oat milk which enhancing and increasing the starter activity (Deswal *et al*, 2014 and and El-Batawy *et al*., 2019). Similar results were reported by Ibrahim ,(2015) , who reported that fortification of camel milk with sodium caseinate , whey protein concentrate , and skim milk powder at 4%increased viscosity, gel firmness and decreased whey syneresis values of camel milk yoghurt .Also ,Omar *et al*. (2019) they reported that replacement of camel milk with skim milk retentate enhanced the starter and probiotic viability of bio yoghurt mad from camel milk during storage at refrigerator temperature for 10 day .

Table 5. Microbiological properties of probiotic camel milk stirred yoghurt containing Oat milk during storage at refrigerator temperature for 15 day.

Properties	Treatments	Storage period (days)		
		1	5	10
Streptococcus thermophiles (cfu/g^{-1})	C	7.82±0.48^{c}	8.26±0.62^{a}	7.64±0.57^{a}
	T1	7.88±0.62^{bc}	8.34±0.74^{a}	7.70±0.68^{a}
	T2	7.92±0.90^{b}	8.42±0.64^{a}	7.76±0.82^{a}
	T3	7.98±0.58^{ab}	8.56±0.46^{a}	7.82±0.90^{a}
	T4	8.16±0.72^{a}	8.64±0.60^{a}	8.0±0.74^{a}
Lactobacillus acidophilus (cfu/g^{-1})	C	7.36±0.72^{a}	7.58±0.36^{a}	7.14±0.52^{a}
	T1	7.42±0.35^{a}	7.66±0.44^{a}	7.22±0.70^{a}
	T2	7.48±0.22^{a}	7.72±0.64^{a}	7.30±0.42^{a}
	T3	7.54±0.65^{a}	7.80±0.48^{a}	7.42±0.36^{a}
	T4	7.62±0.36^{a}	7.86±0.54^{a}	7.58±0.60^{a}
Bifidobacterium. bifidum (cfu/g^{-1})	C	7.62±0.62^{b}	7.68±0.65^{b}	7.56±0.48^{b}
	T1	7.74±0.58^{ab}	7.52±0.46^{b}	7.63±0.34^{ab}
	T2	7.86±0.42^{ab}	7.94±0.72^{ab}	7.78±0.58^{ab}
	T3	8.12±0.60^{a}	8.24±0.55^{a}	7.98±0.46^{ab}
	T4	8.36±0.44^{a}	8.42±0.60^{a}	8.04±0.62^{a}

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**

ND= not detected.

Sensory properties of probiotic camel milk stirred yoghurt containing Oat milk:

Data presented in Table (6) showed that the partial replacement of camel milk with Oat milk increased greatly the sensory attributes of the resultant yoghurt, especially its flavor and body & texture as compared with the control camel milk yoghurt and this increment improved as the percentage of Oat milk increased. Control camel milk yoghurt had the lowest score for sensory properties this may be due to a very weak body & texture and inferior flavor of curd produced from camel milk (Abou-Soliman *et al*., 2017). On the other hand, the use of Oat milk improved all sensory attributes of the resultant yoghurt. Similar results were reported by Marafon *et al*., (2011) they found that supplementing camel milk with milk protein resulted in an increase in the sensory attributes, especially consistency. Also, Omar *et al*. (2019) they reported that replacement of camel milk with skim milk retentate until 30 % enhanced the sensory attributes of the resultant yoghurt. Generally, the sensory properties of all treatments were gradually increased as the storage

period progressed. Similar results were reported by Ibrahim, (2015), who reported that fortification of camel milk with sodium caseinate , whey protein concentrate , and skim milk powder at 1, 2 and 4%increased the sensory attributes scores of the resultant yoghurt up to 14 days during storage period at (4 ±1°C).

Table 6. Sensory properties of probiotic camel milk stirred yoghurt containing Oat milk during storage at refrigerator temperature for 10 day

Components (%)	Storage period (Day)	Treatments				
		C	T_1	T_2	T_3	T_4
Flavor (60)	1	36.4 ±3.30^{c}	41.2±2.74^{b}	41.6±2.66^{b}	42.4±2.94^{ab}	43.6±3.12^{a}
	5	39.2±2.74^{c}	42.7±3.22^{b}	43.0±2.92^{b}	43.6±3.13^{ab}	44.0±2.90^{a}
	10	41.8±2.66^{c}	4.4±2.70^{b}	44.2±3.^{07b}	44.8±2.86^{ab}	45.3 ±3.70^{a}
Body & Texture (30)	1	19.0 ±1.27^{e}	24.0±1.04^{d}	26.0±1.22^{c}	29.0±1.09^{b}	32.0±1.24^{a}
	5	22.0±1.12^{e}	27.0±1.08^{d}	29.0±1.14^{c}	31.0±1.05^{b}	34.0±1.27^{a}
	10	24.0±1.07^{e}	29.0±1.22^{d}	31.0±1.06^{c}	33.0±1.18^{b}	35.0 ±1.07^{a}
Appearance (10)	1	6.9 ±0.38^{c}	7.4±0.30^{bc}	7.6±0.46^{b}	7.9±0.32^{ab}	8.1±0.54^{a}
	5	7.2±0.62^{c}	7.7±0.44^{bc}	7.8±0.74^{b}	8.2±0.68^{ab}	8.3±0.62^{a}
	10	7.4±0.50^{c}	8.0±0.70^{bc}	8.2±0.58^{b}	8.4±0.52^{ab}	8.7 ±0.70^{a}
Total Scores (100)	1	62.3±2.82^{e}	72.6±2.28^{d}	75.2±3.20^{c}	79.3±3.32^{b}	83.7±3.74^{a}
	5	68.4±3.44^{e}	76.97±3.20^{d}	79.8±3.72^{c}	82.8±2.80^{b}	86.3±2.66^{a}
	10	73.04±2.82^{e}	80.4±3.36^{d}	83.4±2.28^{c}	86.2±3.72^{b}	89.0±3.20^{a}

*** Values (means ±SD) with different superscript letters are statistically significantly different ($P \leq 0.05$).**

CONCLUSION

The replacement of camel milk with Oat milk improved the chemical, microbiological, antioxidant, rheological and sensory properties of probiotic camel milk stirred yoghurt. These improvements were proportional to replacement ratio up to 40 % which added nutritive and healthy benefits which added nutritive and healthy benefits to resultant probiotic camel milk yoghurt.

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انتاج اليوجورت المقلب الحيوي من لبن الابل ولبن الشوفان

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تم دراسة تأثير الاستبدال الجزئي للبن الإبل بلبن الشوفان على الخصائص الفيزوكيميائية والريولوجية والميكروبيولوجية والنشاط المضاد للاكسدة والحسية لليوجورت لبن الإبل المقلب الحيوي خلال التخزين. حيث تم صُناعة اليوجورت المقلب الحيوي من لبن الإبل كعينة للمقارنة ، أما المعاملات الأخرى فقد صنعت من لبن الإبل بعد استبدال 10 و 20 و 30 و 40٪ منه بلبن الشوفان. وتم تحليل اليوجورت المقلب الحيوي المصنّع بعد 1 و 5 و 10 أيام من التخزين عند 4 ± 1 درجة مئوية من حيث الخصائص الفيزوكيميائية والميكروبيولوجية والنشاط المضاد للاكسدة والحسية. أظهرت النتائج أن الاستبدال الجزئي للبن الإبل بلبن الشوفان كان أكثر فاعلية في زيادة محتويات المواد الصلبة الكلية ,البروتين, الرماد ، الكربوهيدرات الكلية ، الحموضة ، اللزوجة ,الأحماض الدهنية الكلية المتطايرة (TVFA) ، المحتوى الفينولي والنشاط المضاد للأكسدة وهذه الزيادات كانت متناسبة مع نسبة الاستبدال. كما أدى الاستبدال الجزئي للبن الإبل بلبن الشوفان إلى تحسين حيوية بكتيريا *Streptococcus thermophiles* و *Lactobacillus acidophilus* و *Bifidobacterium bifidum* وكان هذا التحسن متناسبًا مع نسبة الاستبدال. أظهريوجورت لبن الابل المقلب الحيوي المحتوي على 40٪ من لبن الشوفان أعلى معدلات التحكيم الحسي مقارنة بغيره من معاملات يوجورت لبن الابل المقلب الحيوي ، وخلصت الدراسة إلى أنه يمكن استبدال لبن الإبل بلبن الشوفان حتى 40٪ كمصدر للمكونات النشطة بيولوجيا والأليات الغذائية في تصنيع يوجورت لبن ابل مقلب حيوي ، وقد أدى الاستبدال ب 40٪ إلى تحسين الخصائص الفيزوكيميائية والميكروبيولوجية والنشاط المضاد للاكسدة والحسية لليوجورت الحيوي المقلب الناتج.