Journal

J. Biol. Chem. Environ. Sci., 2018, Vol. 13(3): 315-335
http://biochemv.sci.eg

USE OF EXOPOLYSACCHARIDE-PRODUCING CULTURES TO IMPROVE LOW AND FREE FAT YOGHURT PROPERTIES

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ABSTRACT

This work aimed to use exopolysaccharides producing starter culture to improve the textural, microbiological, rheological and some sensorial characteristics of low and free fat yoghurt properties among the storage period. Three types of low fat and free fat yoghurt were made using control yoghurt starter culture, EPS producing starter culture and YF thermophilic starter culture produce high viscosity and mild acidity containing (*Streptococcus thermophilus* and *Lb. delbrueckii ss. bulgaricus*). The physicochemical, microbiological, textural analysis and sensorial properties of both low and free fat yoghurt types were studied, as well as the changes taking place during storage at 4 °C for 21 days.

The firmness, adhesiveness, cohesiveness, and gumminess of low and free fat yoghurt made using EPS starter culture were improved along the storage period as compared with control yoghurt. WHC and Viscosity significantly increased while, syneresis index decreased in low and free fat yoghurt with EPS producing starter culture and YF thermophilic starter culture along the storage period. Viability of lactic acid bacterial starter cultures were significantly the highest in both free fat and low fat yoghurt with EPS starter culture. The use of EPS starter culture in low and free fat yoghurt types production enhanced the sensory scores (flavour, consistency and appearance) of low fat yoghurt followed by free fat yoghurt among the storage period.

Key words: low fat, free fat, exopolysaccharide starter culture, yoghurt, texture analysis, viscosity, storage period

INTRODUCTION

Yoghurt is one of the most important and famous fermented dairy products in all over the world. Generally, yogurt is made by fermentation of milk with lactic acid bacterial starter culture, traditionally *Streptococcus thermophilusand Lactobacillus delbrueckii ssp. bulgaricus*. Basically, there are two different types of products: set-style yogurt and stirred yogurt (**Tamime and Robinson, 2007**).

In recent years, consumers demand has been increased for low fat or free fat yoghurt but their physical properties are less attractive than those of full-fat yoghurt. yoghurt, due to their potential health and nutritional benefits. Fat has been associated with an increase in risk of obesity, coronary heart disease and elevated blood pressure. Higher consumption of low fat milk products can lead to lower risk of coronary heart diseases, and colon cancer (**Kaminarides, *et al.*, 2007; Ramchandran and Shah, 2009**). The dramatic rise in demand for fermented milk over the past 3 decades has also expanded the market for low and free fat fermented milk, but interest of these products remains limited because they do not possess the functional attributes of full fat fermented milk (**Belén García-Gómez *et al.*, 2018**). Low and free fat yoghurt suffers a lot of low organoleptic and rheological properties and exhibits whey separation (syneresis) and low water holding capacity (**Harwalkar and Kalab, 1986 and Hassan *et al.*, 2003**).

However, stabilizers and fat replacers can be used to improve low fat yoghurt properties, but stabilizers can adversely affect the rheological and organoleptic properties of yoghurt. Therefore, an alternative want to improve flavor, texture and rheological properties of yoghurt is the use of starter culture bacteria produce exopolysaccharide (EPS) (**Prasanna *et al.*, 2013**) or addition of exopolysaccharides powder in making of yoghurt (**Doleyres *et al.*, 2005**).

Several researches have shown that the EPS production by various starter in yoghurt could improve the rheological properties, sensory characteristics and prevent syneresis and to replace stabilizers (**Kailasapathy, 2006; Purwandari *et al.*, 2007**). Microbiological and physicochemical properties of among storage period of yoghurt play an important role in acceptability of yoghurt. Exopolysaccharide (EPS) producing*Bifidobacterium longum ss. infantis* CCUG 52486 was used in set yoghurt production and also exhibited lower syneresis than control yoghurt and the highest storage modulus and firmness along the storage period (**Prasanna *et al.*, 2013**).

The present study aimed to produce low fat and fat free yoghurts with the use of EPS producing strain cultures, and evaluate the role of the EPS producing starter cultures towards the chemical, microbiological, rheological properties and organoleptic scores of low and free fat yoghurts during storage at4 °C for 21 days.

MATERIALS AND METHODS

Milk standardization and pretreatment

Fresh raw cow's milk (~3.3 % fat and 8.65 % SNF) was obtained from the herd of the Faculty of Agriculture, Cairo University. Milk fat separated to obtain milk with 1.5% fat (low fat) and skimmed milk (less than 0.01% fat). Spray dried skim milk (low heat treated) [VARIMEX Poland] was used to standardize total solids to 12%.

Starter cultures propagation

Skim milk medium was prepared according to **Harrigan and Maccance (1998).** Skim milk powder was reconstituted to 12% total solids with distilled water and sterilized at 121 °C for 10 min, subsequently cooled to the incubation temperature (42 ±1°C) and inoculated at level of 1% starter culture until coagulation. Starter cultures were propagated 3 times before using in yoghurt preparation.

Yoghurt starter cultures were obtained from the Egyptian Microbial Culture Collection [EMCC] at Cairo Microbiological Resources Center (Cairo MIRCEN), Faculty of Agriculture, Ain Shams University.Commercial frozen starter cultures FD-DVS YF-L811 Yo-Flexs® from (Chr. Hansen, Hørsholm, Denmark) was purchased and used throughout the study.

Preparation of low and free fat set yoghurt and sampling for analysis

Low fat and skim milk was standardized to 12% (w/v) total solids with skim milk powder, and addition of the powder was carried out at 60 °C, followed by thorough mixing using a laboratory mixer. Standardized milk was heated to 95±1 °C and held at this temperature for 5 min in a thermostatically controlled boiling water bath.

Six batches of yoghurt were thus prepared: a) control low and free fat yoghurt, with non EPS producing yoghurt bacteria (*Streptococcusthermophiles* and DSMZ 20479 and *Lactobacillus delbrueckii ss. bulgaricus* DSMZ 20080; b) YE low and free fat yoghurt with *Streptococcus thermophiles* produce EPS and *Lactobacillus delbrueckii ss. bulgaricus* DSMZ 20080 and c) YF low and free fat yoghurt using FD-DVS YF-L811Yo-Flexs® CHR Hansen thermophilic starter culture produce high viscosity and mild acidity containing (*S. thermophilus* and *L. delbrueckii ss. bulgaricus*).

Propagated starter cultures were inoculated each at a ratio of 1% (v/v). The inoculated low and free fat yoghurt mix was mixed thoroughly and poured in 150 mL polystyrene cups with lids; these were incubated at 42±1°C until the pH reached 4.6. After the fermentation, yoghurt treatments were cooled by transferring them into a refrigerator at 4±1 °C, where they were stored for 21 days. low and free fat yoghurt samples were taken from each yoghurt batch at day fresh, 3, 7, 14 and 21days of storage for analysis.

Analytical methods

1- Chemical properties

Samples were analyzed for titratable acidity (as % lactic acid), was determined as described by **Ling (1963)**.Titratable acidity was measured by titrating 10 ml of sample with 0.1 N NaOH solution using phenolphthalein as the indicator. Values of pH were measured by using laboratory pH meter (Beckman electric pH meter) with combined glass electrode Model 3305 pH meter.

2- Rheological properties

Low and free fat yogurt samples were analyzed for texture profile parameters. Texture Analyzer, TA-XT2i (Stable Micro Systems, Co., Ltd) was used to measure texture parameters like hardness, adhesiveness, cohesiveness, springiness and gumminess. Textural properties were analyzed by performing two sequential compression tests with a cylindrical shaped probe with a diameter of 25 mm separated by a rest phase of 30 s. Samples were compressed up to 70% of their original length. Pre-test, during test and post-test speeds during textural analysis were 4, 1 and 1 mm per second, respectively. All the measurements were carried out in quintuplicate. Hardness, adhesiveness, cohesiveness, springiness and gumminess values were calculated from the obtained profiles using the software provided by Stable Microsystems.

The method described by **Bensmira and Jiang (2012)** was adopted to determine the water holding capacity (WHC) and the test was conducted in triplicates.

Spontaneous whey separation (syneresis) was removed and quantified as suggested by **Lucey (2004).** Spontaneously expelled whey (Syneresis) is the shrinkage of the set gel and primarily occurs due to rearrangements of the network.

Apparent viscosity (at the shear rate of 57.6/sec) of fermented milk samples was measured and calculated according to **Schaffner and Beuchat (1986)** using a coaxial rotational viscometer (RHEOTEST 2-Germany) at shear rates ranging from 1 to 437.4 /sec. The measuring device (S2) was used with a samples volume of 30 ml per run. All samples were adjusted to the room temperature (23 ±1 °C) before loading it in the viscometer device. Apparent viscosity was estimated using an equation: $\eta app = t / \gamma$ x100 and t = z. αα where:

η app = apparent viscosity (mpa.s), t = shear stress (dynes/cm2), γ= shear rate (sec-1), z = cylinder (constant S2) and α = read out value.

3- Microbiological and rheological quality:

Lactobacillus count was determined using MRS agar (deMann, Rogasa and Sharpe) according to **De Man *et al.* (1960)**. For the selective enumeration of *L. delbrueckii* ss. *bulgaricus* pH modified (4.58) MRS agar was used (Oxoid Ltd., Hampsher, England). The plates were incubated at 42±1^{o}C for 48h. *Str. thermophilus* count was determined using M17 agar (**Terzaghi and Sandine, 1975**). The plates were incubated at 37±1^{o}C for 48h.plates were counted using a colony counter and expressed as CFU/ml. All chemicals used were obtained from Sigma–Aldrich (St. Louis, MO, USA).

4- Sensory evaluation:

Consumer acceptability of low and free fat yogurt samples was studied when fresh and among the storage period till 21 days of storage at 4 °C. A panel consisting of 12 staff-members of the Food Science Department, Faculty of Agriculture, Ain Shams Univ. The evaluated organoleptic properties included: (a) six attributes for flavour and taste (no criticism: 10; sour: 9; creamy: 9–7; sweet: 9–7; lack of flavour: 9–7; cooked: 9–6 and other: 5–1); (b) four characteristics of consistency (no criticism: 5; gel-like: 4–2; ropy: 3–1; too firm: 4–2 and too thin: 4–1) and (c) four terms describing appearance (no criticism: 5; atypical color: 4–2; lumpy: 4–2; shrunken: 4–1 and whey syneresis) as in method described by **Tamjidi *et al.*, (2012) and Bodyfelt *et al.*, (1988)**.

5- Statistical analysis:

The obtained results were conducted with using two-way analysis of variance (ANOVA) with a 95% confidence interval using ANOVA data and the general linear models' procedure of SAS (**Statistical Analysis System User's Guide SAS, 2010**) (SAS Institute, Inc., U.S.A.). Duncan multiple tests were carried for multiple comparisons among means ($p< 0.05$) of all the data.

RESULTS AND DISCUSSION

Titratable acidity and pH value:

The changes of pH value and titratable acidity (%) of low and free fat yoghurt type among refrigerated storage (4°C) for 21 days presented in **Fig. (1).** The data shows a progressive decrease in pH values and gradual increase in titratable acidity in all yoghurt samples along the storage period. No significant differences were observed in pH value and titratable acidityfresh samples. There were significant differences between low and non- fat yoghurt samples after 7 days of the storage. Low fat yoghurt samples made with YE starter culture followed by low fat yoghurt with YF starter culture had the highest pH value and the least significant acidity (as % lactic acid) along the storage period. A similar trend was in results observed by **Ramchandran and Shah (2010)** in probiotic yogurts. The obtained data were in harmony with those of **Ana Carolina *et al.*, (2015)** in low fat yogurt supplemented with *Pleurotusostreatus* aqueous extract.

On the contrary, the least significant pH value and titratable acidity was recorded in free fat control yoghurt. Control free fat yoghurt showed the lowest pH after 21 days of storage. While, the highest significant pH value was recorded in low fat yoghurt with EPS producing starter culture. So, the application of starter cultures that produce EPS to free fat and low fat yoghurt is an effective method to improve the pH value and titratable acidity along the storage. The data were in agreement with those of **McCann *et al.*, (2011**) in yoghurt with fibers and **Aida *et al.*, (2009)** in yoghurt containing non-digestible carbohydrates.

Viability of lactic acid bacteria:

Fig. (2) shows the changes in starter culture viability in low and free fat yoghurt among the storage at 4°C± 1 for 21days. In fresh samples, counts of *Streptococcus thermophilus* were significantly high in free fat yoghurt with EPS producing starter culture (9.45 $\log_{10}$ CFU/ml) and the least significant counts were in control low fat yoghurt (8.91 $\log_{10}$ CFU/ml). After 3 days of the storage period, viability slightly increased in all yoghurt treatments followed by gradual decrease during storage up to 21 days. The viability of *Streptococcus thermophiles* along the storage period was found to be dependent on the starter culture type. Furthermore, *Streptococcus thermophilus* viability was significantly the highest in low fat yoghurt with EPS followed by low fat YF yoghurt.

On the other hand, *Lactobacillus* count ($\log_{10}$ CFU/ml) was significantly higher in fresh free fat yoghurt samples and slightly increased till 3 days of the storage followed by a gradual decrease in *Lactobacillus* viability till 21 days of the storage. Generally, the least significant *Lactobacillus* viability was in control free fat yoghurt followed by control low fat yoghurt samples.

EPS produced from starter culture may be play an important role in starter culture viability along the storage period more than thermophilic starter culture produce high viscosity and mild acidity containing (*S. thermophilus* and *L. delbrueckii ss. bulgaricus*). Also, mild acidity produced as the storage period progressed had low effect on viability of both *S. thermophilus* and *L. delbrueckii ss. bulgaricus* in low and free fat yoghurt. **Ana Carolina (2015)** found that, viable counts of *S. thermophilus* and *L. bulgaricus* decreased during the cold storage of low fat yogurt.

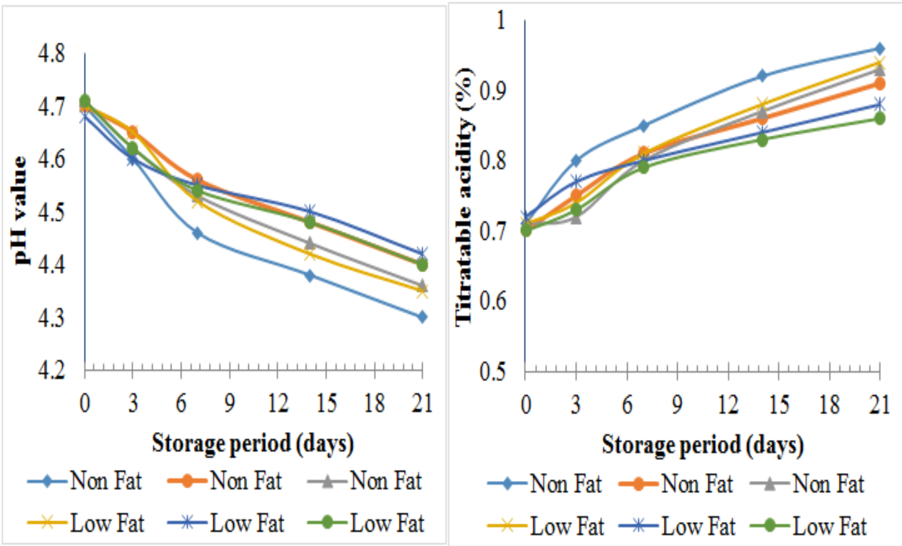

Fig (1): The pH value and titratable acidity (as lactic acid %) of low and free fat yoghurt type among refrigerated storage (4°C) for 21 days.

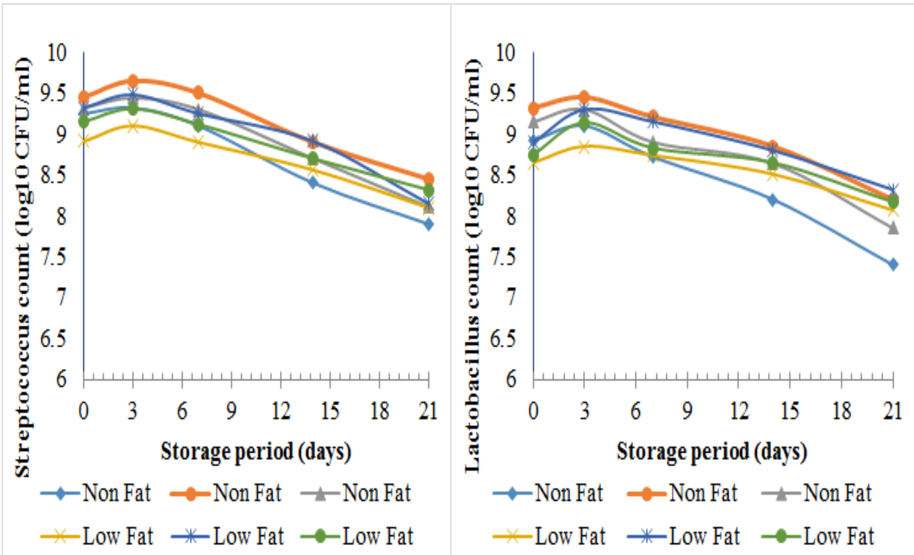

Fig (2): Lactic acid bacterial counts (log_{10} CFU/ml) in low and free fat yoghurt type among refrigerated storage (4°C) for 21 days.

Texture properties:

Yoghurt exhibits a variety of non-Newtonian effects. One of the most important characteristics for yoghurt quality is texture. Textural profile analysis (TPA) is considered as a useful technique used for evaluating texture parameters. The firmness (hardness), adhesiveness, cohesiveness, and gumminess of low and free fat yoghurt along the storage at 4°±1 for 21 days are presented in **Figure (3).**

1. **Effect on firmness**

Generally, firmness (hardness) of yoghurt is the most important parameter for texture evaluation. Also, hardness is considered as a measure of firmness of the yogurt and regarded as the force required to attain a certain deformation (**Ozcan and Kurtuldu 2014; Trinh *et al.,* 2012**). Both of starter culture type and storage period affected the firmness of low and free fat yoghurt.

Firmness value of fresh and refrigerated stored low fat yoghurt was less than firmness of free fat yoghurt along the storage period. Control low and free fat yoghurt had the least significant ($p < 0.05$) firmness when fresh and along the storage period. Firmness value was the least in control fresh low fat yoghurt (44.9± 0.2) and significantly increased by increasing the storage period to reach (45.3±0.3) at the end of the storage period. Firmness values were high in free fat yoghurt types as compared with low fat yoghurt type when fresh and along 21 days of the storage period.

The use of EPS producing starter culture YE increased the firmness of all yoghurt samples compared with control yoghurt and YF starter culture. Fresh and stored free fat yoghurt samples made with EPS producing starter culture (YE) had the highest significant firmness values. Firmness value gradually increased (significant increase $p \leq 0.05$) as the refrigerated storage increased in all low and free fat yoghurt type samples. **Akalin *et al.,* (2012)** observed a positive correlation between protein levels. Also, they found that firmness in yoghurt made with milk supplemented with skim milk powder did not change during storage ($P > 0.05$). On the contrary, firmness values of probiotic yogurts made with milk fortified with milk proteins significantly increased during storage ($P < 0.05$).

2. Effect on adhesiveness

Adhesiveness is considered as the force required to remove the adhered material in the mouth while eating. It is regarded as a measure of stickiness of yogurt and is inversely related to eating quality of the yogurt (**Mudgil *et al.*, 2017**). Fig (3b) shows adhesiveness of low and free fat yoghurt along the storage at 4°±1 for 21 days. Generally, adhesiveness slightly increased in all treatments by increasing the storage period. A significant effect was observed for the adhesiveness of the yoghurt made with YE starter culture. The control low fat yoghurt was least adhesiveness ($P \leq 0.05$) probably due to the lowest protein content which attribute to the adhesiveness of the yoghurt.

Free fat yoghurt made with YE starter culture had the highest significant adhesiveness values along the storage period followed by Free fat yoghurt made with YF starter culture. Adhesiveness of low and free fat yoghurts significantly influenced by starter culture type and the storage period. The obtained data were in agreement with those of **Akalin *et al.*, (2012)** who found that the adhesiveness values increased as the storage period increased of yoghurt fortified with sodium caseinate or whey protein concentrate.

3. Effect on cohesiveness

Cohesiveness is the level to which a material can be deformed before it is ruptured and is measure of the strength of internal bonds (**Guinee 2003**). Cohesiveness is an important parameter for analyzing the yogurt texture. Also, cohesiveness related to consumer acceptability and satisfactoriness of yogurt. Cohesiveness of low and free fat yoghurt treatments among refrigerated storage at 4°C for 21 days are presented in **Fig (3c)**. The use of EPS producing starter culture (YE or YF) improved the cohesiveness values of low and free fat yoghurt when fresh and among the storage period.

Moreover, there were significant effects of starter culture type and the storage period on cohesiveness values of all low and free fat yoghurt treatments. Cohesiveness values significantly decreased as the storage period progressed in both low and free fat yoghurt treatments. On the contrary, the least significant cohesiveness values were recorded in fresh and stored control free fat yoghurt as compared with control low fat yoghurt samples. The highest significant cohesiveness values were in fresh low fat yoghurt made with YE starter culture followed by fresh low fat yoghurt made with YF starter culture and significantly decrease by increasing the storage period.

EPS producing starter cultures enhanced the cohesiveness value of both low and free fat yoghurt. The data were in agreement with those of (**Sodini *et al.*, 2002**) who reported that, the rheological parameters of fermented milk samples were strongly influenced by the starter culture type.

4. Effect on gumminess

Gumminess is an important parameter for textural analysis of yogurt and level of gumminess acceptance in yogurt depends on the consumer acceptability. **Fig. (3d)** presents gumminess values of low and free fat yoghurt treatments among refrigerated storage at 4°C for 21 days. It could be observed that, EPS starter culture (YE) followed by (YF) starter culture type had a highest significant effect on gumminess values in fresh and stored low and free fat yoghurt. On the contrary, the least significant gumminess values were found in control free fat followed by control low fat yoghurt samples.

Furthermore, gumminess values of all yoghurt samples significantly decreased as the storage period increased. Gumminess of fresh and stored control free fat yoghurt were significantly low as compared with gumminess of fresh and stored control low fat yoghurt. EPS starter culture improved gumminess values of both low and nonfat yoghurt samples when fresh and along the storage period. **Mudgil *et al.*, (2017)** reported that, the starter culture type and level significantly affected on gumminess values. Also, gumminess of yoghurt increased upon increase in starter culture concentration.

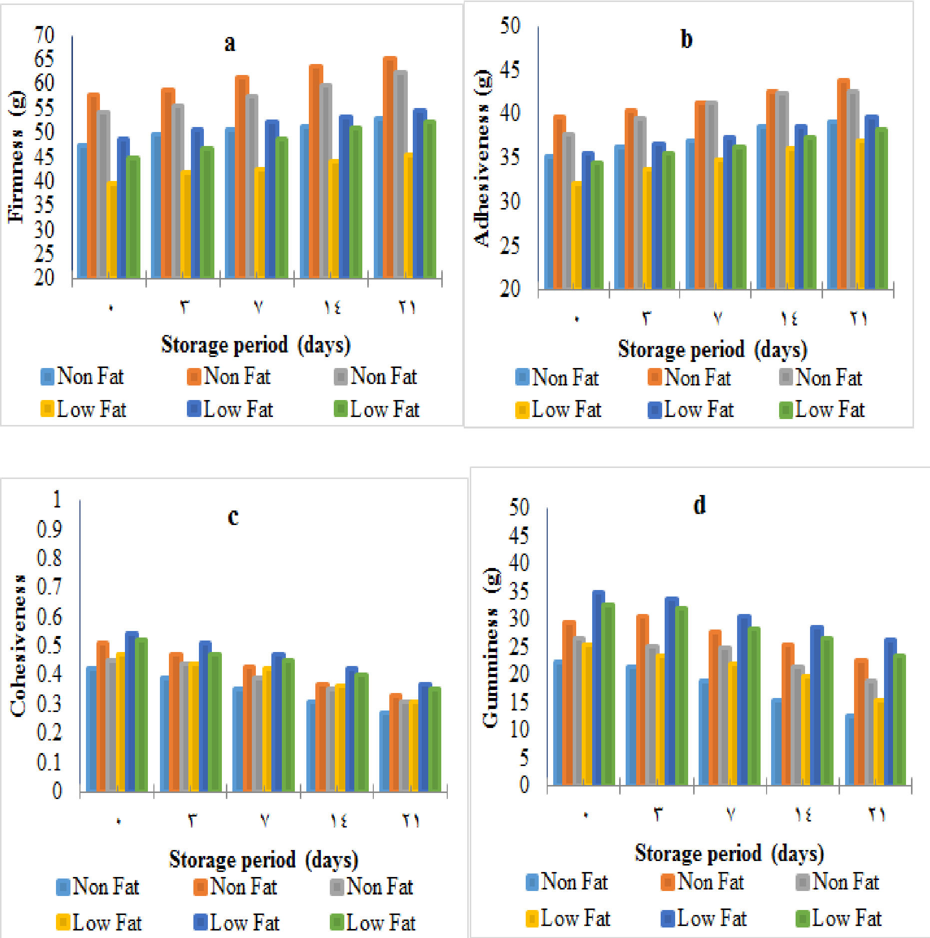

Fig (3): Texture profile (firmness, adhesiveness, cohesiveness and gumminess) of low and free fat yoghurt among refrigerated storage at 4°C for 21 days.

Rheological properties

1- Water holding capacity (%) and whey syneresis index

Water holding capacity and whey syneresis are most important structural characteristics of set-type yogurt. They denoted to the strength of coagulum and its stability during storage of full, reduced and free fat set-type yogurt. The average water holding capacity (%) and whey syneresis values of low and free fat yoghurt among refrigerated storage at 4°C for 21 days are shown in **Fig. (4).** It could be observed that, the water holding capacity (WHC) of low and free fat yogurt significantly increased with the use of EPS producing starter culture (YE) followed by use of YF starter culture. The least significant WHC (%) was in control free fat yoghurt samples. WHC (%) slightly decreased among 14 days of the storage period followed by significant ($P < 0.05$) decrease after 21 days of the storage period in all yoghurt treatment samples.

Control free fat followed by control low fat yogurt samples exhibited the lowest level of WHC throughout the storage period. WHC of all low and free fat yoghurt samples slightly decreased with increasing of the storage period. Whereas, the highest WHC level was obtained by using EPS starter culture (YE). So, the use of EPS producing starter culture enhanced WHC of both low and free fat yoghurt when fresh and along the storage period. A significant decrease ($P < 0.05$) was observed in WHC of all yoghurt samples after 14 days of the storage period. WHC of yoghurt can be affected by biochemical event (looser bonds between H_2O molecules and whey protein) with the decrease in pH to the end of storage (**Akalin *et al.*, 2012**).

Syneresis index of all yoghurt samples significantly decrease ($P < 0.05$)as the storage period progressed. Furthermore, control free fat yoghurt samples had the highest significant syneresis index when fresh and along the storage period. While, the least significant syneresis index was recorded in low fat yoghurt type made with EPS producing starter cultures followed by low fat yoghurt type with YF starter culture. **Britten and Giroux, (2001)** reported that the reduction of whey syneresis index corresponds to the improvement of WHC in whey protein, which increases with denaturation among heat treatment of milk. **Tamime and Robinson, (1999)** stated that, the

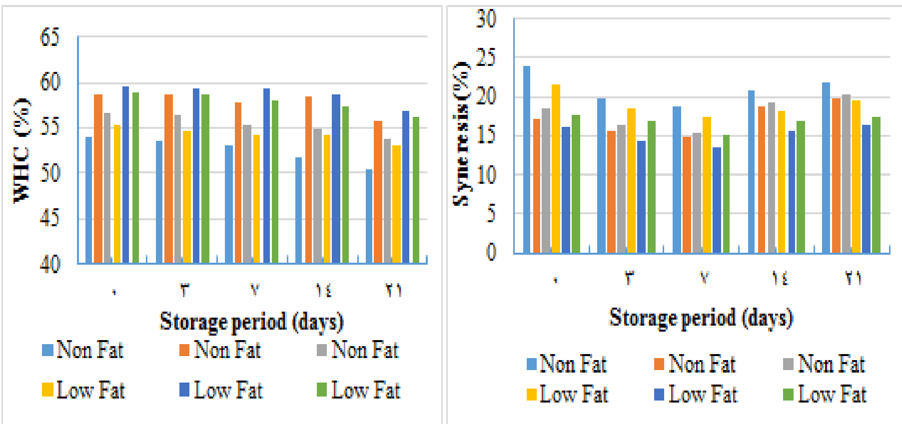

Fig. (4): Water holding capacity (WHC) (%w/w) and whey syneresis (ml/100g) of low and free fat yoghurt among refrigerated storage at 4°C for 21 days.

Hydroxyl groups and negatively charged groups in polysaccharides are prone to binding water to form hydration state increase the WHC and syneresis index of yoghurt.

2- Apparent viscosity

Apparent viscosity of yoghurt is affected by the strength and number of bonds between casein micelles, as well as their structure and three-dimensional distribution (**Lucey and Singh 1998; Zahra Izadi *et al.*, 2014**). Apparent viscosity of low and free fat yoghurt among refrigerated storage at 4°C for 21 is shown in Fig. (5). The data reveal that, yogurt samples produced with EPS producing starter cultures (YE) followed by YF starter culture had the highest viscosity, while control yoghurt samples had the smallest viscosity. Also, apparent viscosity significantly of all low and free fat yoghurt samples increased ($P < 0.05$) by increasing the storage period. The least significant apparent viscosity was in free fat yoghurt as compared with low fat yoghurt.

Significant statistical differences were also found for the index of viscosity ($P < 0.05$). The highest value for index of viscosity was obtained for the control free fat yoghurt samples followed by control low fat yoghurt. In addition, starter culture type and storage period significantly influenced the apparent viscosity of all low and non- fat yoghurt samples. Yogurt is suggested to have weak bonding, but milk supplementation with skim milk powder or caseinate tends to change the gel structure and subsequently increase in viscosity of yoghurt (**Sodini *et al.*, 2004; Damin *et al.*, 2009**). **Tamjidi *et al.*, (2012)** conducted that, the exopolysaccharides produced by the lactic acid bacteria in yogurt, play a significant role in the rheology of stirred yogurt.

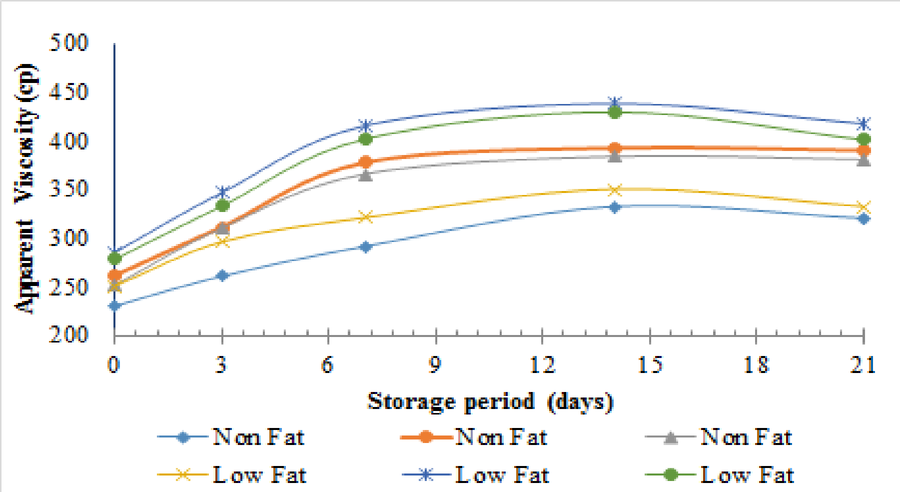

Fig. (5): Apparent viscosity of low and free fat yoghurt among refrigerated storage at 4°C for 21 days.

Sensory Evaluation

Results from the sensory evaluation of low and free fat yoghurt treatments based on the attributes of flavour, consistency and appearance are presented in **Table (2).** No significant difference was observed in flavour, consistency and appearance acceptability in all fresh and 3 days stored samples followed by significant decrease over the storage period. However, Flavour, consistency and appearance scores of low fat yoghurt were significantly higher than free fat yoghurt samples.

Flavour, consistency and appearance scores were significantly higher in both low and free fat yoghurt with EPS producing starter culture (YE) than in control low and free fat yoghurt along the storage period ($P < 0.05$).

The highest flavour score was recorded in low fat yoghurt with EPS producing starter culture (9.55) followed by YF starter culture (9.35). This may be due to the highest viability of lactic acid bacterial counts in fresh and stored YE samples. On the contrary, the least flavour scores were recorded in free fat control yoghurt sample when fresh and along the storage period. Flavour scores significantly decreased after 7 days of the storage period ($P < 0.05$).

Consistency scores of both low fat yoghurt with EPS producing starter culture and YF starter cultures were significantly the highest when fresh and along the storage period ($P < 0.05$). On the contrary, free fat control yoghurt had the least significant consistency scores among the storage period. There was significant decrease in consistency scores of all yoghurt samples as the storage period progressed from 7 days till 21 days.

No significant change in appearance scores of all fresh and 3 days stored yoghurt samples followed by significant decreased till the end of the storage period. Generally, free fat control yogurts (Y) received lower appearance scores along the storage period ($P < 0.05$) as compared with low fat control yoghurt samples. Low and free fat yoghurt with EPS producing starter culture followed by yoghurt with YF starter culture had the highest significant appearance scores when fresh and along the storage period.

The sensory scores (flavour, consistency and appearance) data were in agreement with those of **Akalin *et al*., (2012)** and **Amjidi *et al*., (2012).** Also, **Marafon *et al*., (2011)** stated that, appearance, scores on in probiotic yogurts produced by partial replacement of skim milk powder (45%) with whey protein concentrate decreased along 28 d of the storage.

It could be concluded that, use of EPS starter cultures (YE) improved the textural, microbiological rheological and sensorial characteristics of both low and free fat yoghurt compared with yoghurt made with YF or control starter cultures. Also, water holding capacity (%) and whey syneresis index of YE starter culture improved general acceptability of low and free fat yoghurt samples.

Table (2): Sensorial characteristics of low and free fat yoghurt among refrigerated storage at 4°C for 21 days.

Yoghurttype	Treatment	Storage period (days)				
		Fresh	3	7	14	21
Flavour (10 points) Low fat	Y	9.04^{Ac}	9.11^{Ac}	8.75^{Bc}	8.25^{Cc}	8.03^{Dd}
	YE	9.55^{Aa}	9.64^{Aa}	9.17^{Ba}	9.03^{Ba}	8.45^{Ca}
	YF	9.35^{Ab}	9.45^{Ab}	9.02^{Bb}	8.86^{Cb}	8.22^{Db}
Free fat	Y	8.13^{Af}	8.33^{Ae}	8.02^{Bf}	7.85^{Ce}	7.14^{De}
	YE	8.64^{Ad}	8.65^{Ad}	8.52^{ABd}	8.36^{Bd}	8.13^{Cc}
	YF	8.52^{Ae}	8.58^{Ad}	8.32^{Be}	8.15^{Cc}	8.02^{Cd}
Consistency (5 points) Low fat	Y	4.17^{Ac}	4.11^{cd}	3.85^{Bd}	3.52^{Cd}	3.37^{Dd}
	YE	4.64^{Aa}	4.71^{Aa}	4.58^{Ba}	4.25^{Ca}	4.11^{Da}
	YF	4.53^{Aab}	4.55^{Aab}	4.21^{Bb}	4.06^{Cb}	3.85^{Db}
Free fat	Y	3.86^{Ad}	3.91^{Ad}	3.74^{Be}	3.41^{Ce}	3.18^{De}
	YE	4.38^{Ab}	4.40^{Ab}	4.15^{Bbc}	4.08^{Bb}	3.84^{Cb}
	YF	4.19^{Ac}	4.22^{Ac}	4.11^{Bc}	3.89^{Cc}	3.62^{Dc}
Appearance (5 points) Low fat	Y	4.21^{Ad}	4.18^{Acd}	4.03^{Bc}	3.82^{Cd}	3.46^{Dd}
	YE	4.85^{Aa}	4.86^{Aa}	4.70^{ABa}	4.62^{Ba}	4.41^{Ca}
	YF	4.62^{Aab}	4.64^{Ab}	4.55^{Ba}	4.41^{Cb}	4.25^{Db}
Free fat	Y	4.06^{Ae}	4.02^{Ad}	3.85^{Bd}	3.61^{Cd}	3.22^{De}
	YE	4.45^{Ab}	4.34^{ABc}	4.25^{Bb}	4.12^{Cc}	4.02^{Dc}
	YF	4.32^{Ac}	4.25^{ABc}	4.13^{Bb}	4.06^{BCc}	3.91^{Cc}

Means (n = 12) of every characteristic followed by different small letters in the same column are significantly different (P < 0:05) and different capital letters in the same row are significantly different (P < 0:05)

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استخدام مزارع بادئات منتجة للسكريدات العديدة في تحسين خواص اليوجهورت منخفض وخالي الدهن

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يهدف البحث إلي: استخدام مزارع بادئات بكتريا حمض اللاكتيك المنتجة للسكريدات العديدة Exopolysaccharide فى تحسين صفات التركيب والخواص الميكروبيولوجية والرويولوجية والحسية لكل من اليوجهورت المنخفض الدهن واليوجهورت عديم الدهن خلالفترة التخزين المبرد.

تم تصنيع ثلاثة أنواع مختلفة من اليوجهورت منخفض الدهن واليوجهورت خالي الدهن بإستخدام مزارع بادئ اليوجهورت التقليدي (مقارنة) و مزرعة بادئ اليوجهورت المنتجة للسكريدات العديدة وكذلك مزرعة بادئ اليوجهورت المنتجة للزوجة العالية والحموضة المتوسطة. وقد تم دراسة خواص التركيب والخواص الفيزيوكيمائية والميكروبيولوجية والحسية لكل من اليوجهورت المنخفض وعديم الدهن خلال فترة التخزين المبرد على حرارة 4 °م لمدة 21 يوم.

وقد أوضحت النتائج حدوث تحسن فى كلاً من فى درجة الصلابة ومدى الإلتصاقية ومدى التماسك وكذلك لزوجة كلاً من اليوجهورت المنخفض الدهن الخالي من الدهن المنتج باستخدام البادئ المنتج للسكريدات العديدة خلال فترة التخزين التخزين المبرد على حرارة 4 °م لمدة 21 يوم. كما حدثت زيادة معنوية فى كلاً من قدرة اليوجهورت على الإحتفاظ بالشرش واللزوجة بينما إنخفضت قدرة اليوجهورت على طرد الشرش فى كلاً من اليوجهورت الناتج باستخدام البادئ المنتج للسكريدات العديدة يليه البادئ المنتج للزوجة العالية وذلك خلال فترة التخزين. كانت حيوية مزارع البادئات مرتفعة بدرجة معنوية فى كلاً من اليوجهورت عديم الدهن يليه اليوجهورت منخفض الدهن الناتج بإستخدام البادئ المنتج للسكريدات العديدة خلال فترة التخزين. أيضاً، فإن استخدام البادئ المنتج للسكريدات العديدة أدى إلى تحسين الصفات الحسية (النكهة والتركيب والمظهر) لكلاً من اليوجهورت منخفض الدهن يليه اليوجهورت الخالي من الدهن خلال فترة التخزين.