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Physicochemical, Microbiological Quality and Organoleptic Properties of Yoghurt Supplemented with Linseed Oil

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ABSTRACT

Linseed oil is derived from the seeds of flaxseed (*Linum usitatissimum* L.), a plant widely cultivated for fiber or oil for industrial use. The aim of this study was to investigate the influence of milk supplementation with flaxseed oil with different percentage I.E., 0.0, 0.5, 1.0, 1.5 and 2.0 on the physico-chemical, microbiological and organoleptic characteristics of yoghurt during storage at 6^{0}C for 14 days. The obtained results showed that total solids, acidity, fat, ash and total volatile fatty acids (TVFA) of yoghurt manufactured from milk supplemented with linseed oil were higher than that of control until day 14^{th}. There were marked variations in the fat content and TVFA value of the products. Yoghurt supplemented with 2% linseed oil exhibited lower pH value compared with other treatments. However, yoghurt supplemented with linseed oil showed gradual increase in total bacterial count and yeast & mould apparent on the 7^{th} day of storage while all samples showed a gradual decrease on 14^{the} day. Yoghurt samples supplemented with different percentage of linseed oil had higher in curd tension and whey syneresis compared with control. Results of the present study indicated direct relationship between all percentage of linseed oil and quality with higher levels of linseed oil. Results of the sensory evaluation revealed that flavour, consistency and appearance was significantly affected ($p<0.05$) on yoghurt samples. The colour of yoghurt was changed towards yellowness with the increase in the percentage of added linseed oil. Yoghurt containing linseed oil had slightly significant ($P<0.05$) decreased the acceptance level of aroma and texture of yoghurt. It could be concluded that the supplementing milk with linseed oil at percentage 1.0% was the most acceptable.

Keywords: Yoghurt; linseed oil; physicochemical; microbiological quality; organoleptic properties; curd tension.

INTRODUCTION

Yoghurt is one of the common dairy products and its nutritional value has a same composition of milk from which it was produced. Yoghurt, belongs to fermented milks, has increased its world popularity and consumption **(**Tamime, and Robinson, 1999).Yoghurt consumption in the area for the more available dairy products is more than other products. Human consumption of yoghurt has been associated with tremendous health benefits due to improvement of gastrointestinal functions and disease risk reduction (Heyman, 2000).

Yoghurt is a balance source of protein, fats, carbohydrates and mineral for children (Bibiana *et al*., 2014).The production of yoghurt with omega-3 fatty acids may be an alternative for the increasing market of health-conscious consumers and may contribute to an expansion in omega-3 fatty acids consumption in the population. Human consumption of omega-3 fatty acid is proven to decrease the incidence of cardiovascular disease, scale down inflammation and prevent certain chronic diseases such as diabetes, hypertension, cancer, autoimmune diseases and arthritis (Larsson *et al*., 2004).

Flaxseed or linseed (*Linum usitatissimum* L.) is an annual herb belongs to the Linaceae family. It is cultivated worldwide and has been used for its oil seed and fiber since ancient times in Egypt. Flaxseed is a well-known plant source for n-3 polyunsaturated fatty acids (PUFAs) rich oils (El-Beltagi *et al*., 2007). Flaxseed oil has a very healthy fatty-acid profile, with low levels (approximately 9%) of saturated fat, moderate levels (18%) of monounsaturated fat and high concentrations (73%) of polyunsaturated fatty acids (PUFAs). The PUFA content comprises about 16% omega-6 fatty acids, primarily as linoleic acid (LA), and 57% alpha-linolenic acid (ALA C18:3n-3), an omega-3 fatty acid (DeClercq, 2006). The n-3 PUFAs have received increased attention because the consumption of n-3 PUFAs has been linked to reducing danger of coronary heart disease (CHD), inflammatory reactions and lowers the risk of chronic ailment (Gebauer *et al*., 2006). Flaxseed has been consumed for centuries for its good flavour and for its nutritional properties.

Therefore, the aim of this study was to evaluate the influence of genitive linseed oil on the quality of yoghurt and its physicochemical, microbiological and organoleptic characteristics of yoghurt during storage period at 6°C for 14 days.

MATERIALS AND METHODS

Materials:

Fresh cow's milk was obtained from Alkharga City, New Valley Governorate, Egypt. Yoghurt starters were obtained from Chr. Hansens laboratory, (Copenhagen, Denmark), containing *Str. thermophilius* and *L. delbrueckii* subsp. *bulgaricus* .The cultures were propagated separately in sterilized recombined skim milk at the optimum temperature (*Str. thermophilius* at 45^{o}C and *L. delbrueckii* subsp. *bulgaricus* at 38^{o}C) for 16-18 hours, and mixed at rate of 1:1 just before its addition to milk at 1.5%. . Linseed oil was obtained from Eldemerdash factory for the extraction of vegetable oils, (Al -Mahalla al-Kubra, Gharbia Governorate, Egypt).

Methods:

Physicochemical characteristics of linseed oil:

The ordinary oil constants, e.g., acid value, iodine, saponification, and peroxide number were determined according to the methods of AOAC (2000).

Yoghurt manufacture:

Fresh cow's milk (fat 3.0 %, protein 3.5%, TS 11% , acidity 0.17% , pH 6.6 and ash 0.71%) was heated at 90°C for 30 min., rapidly cooled to 65°C and then divided into five equal portions, linseed oil was added to the milk at the ratios of 0% control, 0.5% (T1), 1.0% (T2), 1.5% (T3) and 2.0 (T4) (w/w) and immediately conducted to homogenization (electric Homogenizer at pressure 70 bar), and then inoculated with 1.5% active starter cultures. The inoculated milks were equally distributed into plastic cups, and incubated at 42°C until complete coagulation. After coagulation, samples were held at 6°C for 14 days and analyzed when fresh and at 7 and 14 days of storage. Three replicates were carried out from all treatments when fresh and after 7 and 14 days.

Chemical analysis of the milk and yoghurt:

Total solids, total protein; milk fat , titratable acidity and ash in the raw milk and yoghurt were determined according to the standard methods of AOAC (2000). pH values were measured in milk and yoghurt samples using pH meter (Hanna Instrument 8021), while, total volatile fatty acids were determined as given by Kosikowski (1982).

Microbiological analysis:

Total plate counts, coliforms, moulds & yeasts determination were carried out according to Standard Methods for the Examination of Dairy Product, using the plate count agar (PCA), eosine methylene blue (EMB) and potato dextrose agar (PDA) respectively (Zekai, 2003).

Rheological properties of yoghurt:

Curd syneresis :

Two hundred grams of yoghurt samples were inverted on a fine mesh screen placed on top of a funnel. After 2 h of drainage at refrigerator temperature (5 to 7°C) the quantity of whey collected in a 100-ml graduated cylinder was used as an index of syneresis (Farooq and Haque, 1992).

Curd tension:

The firmness (curd tension**)** of the formed yoghurt gel was expressed as the weight (gm). A 50-ml portion of yoghourt was placed in a 100-ml glass beaker (7 x 4.5 cm) and a H-shaped blade placed in it (Ghosh and Rajorhia, 1990)

Organoleptic evaluation:

The organoleptic properties of resultant yoghurt were assessed by a test panel of 10 persons according to the scheme described by Nelson and Trout (1981).

Statistical Analysis:

The obtained results were evaluated statistically using the software program; the SAS system for windows, release 8.02 TS level 02M0, SAS Institute Inc., Cary, NC, USA (SAS, 1999). Differences between means were determined by Duncan's multiple range tests at a level of 0.05 (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Physicochemical characteristics of linseed oil

Results presented in Table 1 indicated that the saponification value of refined linseed oil was 193±1.73 (mg KoH /g oil) and the obtained results are similar to the results reported by Popa *et al.* (2012) and Masih *et al*. (2014). Przybylski (2005) also showed that the saponification value of linseed oil ranged from 187-195 mg KOH/g. The iodine value of linseed oil was178±0.56, and similar to the results of Popa *et al.* (2012). According to the standards ISO 150, ASTM D234 (Anon, 1998a) and British Pharmacopoeia (Anon, 1998b) linseed oil should have acid value less than 4.0 mg KOH/g oil .The acid value of refined linseed oil was 0.82±0.02 (Table 1) which is similar with previously reported acid value (0.80 mg KOH/ g oil) for linseed oil by Popa *et al.* (2012). The peroxide value of refined linseed oil was 0.94±0.09 which is in line with previous findings by Popa *et al.* (2012).

Table(1).Physico-chemical determination of linseed oil.

Determination	Mean value
Saponification value (mg KOH /g oil)	193±1.73
Iodine value (g I_2/100 g oil)	178±0.56
Acid value (mg KOH /g oil)	0.82±0.02
Peroxide value (meq. O_2/kg oil)	0.94±0.09

Physio-chemical composition of Yoghurt:

Data in Table (2) shows that total solids content of yoghurt increased significantly ($p<0.05$) with the increase of added linseed oil percent and yoghurt produced from milk with flaxseed oil treatment (T4) had the highest total solid content compared with other yoghourt samples .The supplementation of yoghurt with linseed oil may be cause of these differences. These results might be attributed to the contraction of yoghurt curd as a result of developing acidity throughout the storage period, which helps to expel the whey from curd. These results are agreement with those obtained by Foda *et al.* (2012) who found that yoghurt produced from milk supplemented with flaxseed oil contained higher total solid. Moreover, total solid content of yoghurt from different treatments increased significantly ($p<0.05$) during storage period in control yoghurt or that containing different levels of linseed oil throughout storage period.

Changes occurred in protein content between control and experimental yoghurt during storage, indicated that protein content was affected by storage period. There were slightly differences in the content of protein between control and yoghurt supplemented with linseed oil. These results are in agreement with those found by Dhiman *et al*. (1999). The obtained data indicated that yoghurt produced from milk supplemented with linseed oil contained higher fat percentage compared with control. The percentage of fat showed an increasing trend in the higher levels of linseed oil in yoghurt. The same results are in agreement with those obtained by Zhang *et al.* (2006).The obtained results of this study, also cleared the fat contents were increased in yoghurt samples during the storage. This increase in fat content throughout storage might be due to increase the dry matter.

Table (2). Physio-chemical properties of yoghurt produced from milk supplemented with linseed oil during storage period at 6°C for 14 days.

Components	Storage (days)	Control	T1	T2	Treatments T3	T4	Mean
Total solids%	Fresh	10.96±.01	11.91±.01	12.46±.01	12.86±.01	13.07±.01	12.25^{c}
	7	11.37±.01	11.86±.01	12.56±.01	12.87±.01	13.22±.01	12.37^{b}
	14	11.56±.01	11.87±.01	12.56±.01	12.89±.01	13.47±.0	12.47^{a}
	Mean	11.29^{E}	11.88^{D}	12.53^{C}	12.87^{B}	13.25^{A}	
Protein %	Fresh	2.83±.03	3.20±.01	3.10±.01	3.167±.03	3.03±.03	3.07^{b}
	7	3.00±.01	3.10±.01	3.10±.01	3.13±.07	3.00±.01	3.07^{b}
	14	3.10±.01	3.10±.01	3.10±.01	3.13±.03	3.10±.01	3.10^{a}
	Mean	2.97^{D}	3.13^{AB}	3.10^{B}	3.14^{A}	3.04^{C}	
Fat %	*Fresh*	2.93±.03	3.47±.03	3.73±.03	4.10±.35	4.37±.03	3.90^{b}
	7	3.10±.01	3.47±.03	3.80±.01	4.37±.03	4.45±.01	4.01^{ab}
	14	3.20±.01	3.52±.02	3.93±.03	4.47±.03	4.60±.01	4.10^{a}
	Mean	3.08^{D}	3.84^{C}	4.19^{B}	4.31^{B}	4.97^{A}	
Ash %	Fresh	1.05±.01	1.08±.01	1.18±.01	1.18±.01	1.08±.01	1.11^{b}
	7	1.07±.01	1.09±.01	1.18±.01	1.18±.01	1.09±.01	1.12^{a}
	14	1.07±.01	1.09±.01	1.18±.01	1.18±.01	1.09±.01	1.12^{a}
	Mean	1.06^{C}	1.18^{A}	1.18^{A}	1.18^{A}	1.08^{B}	

[abcde] Letters indicate significant differences between Yoghurt treatments
[ABCDE] Letters indicate significant differences between storage times

The ash contents in control yoghurt had lower values than that in experimental yoghurt in fresh and during storage period. Ash content was higher in treatments (T2) and (T3) than in other treatments. Mean of ash content did not change between both treatments (T2); (T3) and treatments (T1); (T4) in fresh samples or during storage period. Higher ash content in experimental yoghurt might be due to high dry matter comparing with the control. Ash content was less in control samples comparison with supplemented samples either in fresh samples or during storage period up to 14 days. The findings of current studies are in concordance with the results reported by Masih *et al*. (2014).

The pH value was decreased in yoghurt supplemented with linseed oil, while the highest pH value was found in control yoghurt. This decrease may be due to the acidic effect of fatty acids of flaxseed (Foda *et al.*, 2012). Researches have shown that linseed oil with different levels added to yoghurt, effect on pH and viability of culture bacteria. According to the results of the present work, pH values of yoghurt samples were higher in control yoghurt than all treatments, which may explained on basis that addition of linseed oil increased concentration of polyunsaturated fatty acid (PUFA) probably exhibited culture of lactic acid bacteria for growth as reported by Kennelly (1996). This could be a result of more bacterial activity, causing more decrease in pH. Changes in pH between samples with high amount of linseed oil was less than the pH changes in control sample as the higher the amount of linseed oil, the less changes of pH during the storage compared to control sample with T1,T2,T3,T4 samples. The acidity of yoghurt samples produced from milk supplemented with linseed oil was higher in comparison with control sample. The same tendency was observed on the treatment (T4) which had the highest acidity percentage ($P<0.05$). This could be due to the presence of polyunsaturated fatty acids (PUFA) in linseed oil which promoted the growth of lactic acid bacteria. These results are in harmony with those of Boycheva *et al.* (2006). As well as, the acidity increased in yoghurt during storage until day 14th in all samples ($P<0.05$). This is a result of the persistent metabolic activity of starters, which has also been called post-acidification (Beal *et al*., 1999). The high acidity in the experimental samples may due to the vegetable oil in them (Bonczar *et al.*, 2002). The decrease in pH and the increase in acidity can be due to the activity of microorganisms that by taking sugar and production of organic acids can lead into the reduction of pH.

Table (3). Physio-chemical properties of yoghurt produced from milk supplemented with linseed oil during storage period at 6°C.

Components	Storage (days)	Control	T1	T2	Treatments T3	T4	Mean
Acidity %	Fresh	0.71±.01	0.78±.003	0.79±.003	0.82±.003	0.85±.003	0.79^{c}
	7	0.84±.003	0.87±.003	0.89±.003	0.92±.003	0.98±.003	0.89^{b}
	14	0.96±.003	1.20±.00^{c}	1.50±.003	1.62±.003	1.73±.012	1.28^{a}
	Mean	0.83^{D}	0.95^{C}	1.06^{B}	1.15^{A}	0.95^{C}	
pH value	Fresh	4.67±.007	4.55±.003	4.49±.003	4.55±.003	4.44±.003	4.56^{a}
	7	4.47±.01	4.35±.003	4.29±.003	4.25±.003	4.14±.003	4.36^{b}
	14	4.32±.003	4.25±.006	4.24±.003	4.11±.000	4.01±.003	4.29^{c}
	Mean	4.89^{A}	4.39^{C}	4.34^{D}	4.41^{B}	4.40^{B}	
TVFA (ml NaOH) /100g	Fresh	21.33±.33	22.67±.33	25.00±.00	26.33±.33	21.33±.33	23.33^{c}
	7	23.33±.33	25.00±.00	25.67±.33	26.67±.33	23.33±.33	24.60^{b}
	14	25.33±.33	26.67±.33	28.67±.33	29.00±.00	25.67±.33	27.07^{a}
	Mean	23.33^{D}	24.78^{C}	26.44^{B}	27.33^{A}	23.11^{D}	

[abcde] Letters indicate significant differences between Yoghurt treatments
[ABCDE] Letters indicate significant differences between storage times

The changes in the TVFA of control and yoghurt supplemented with linseed oil during storage are shown in Table 3. There were a significant differences (P <0.05) in the TVFA between control and yoghurt supplemented with linseed oil until day 14. The TVFA was higher in experimental yoghurt. Similar observation was found in experimental yoghurt sample T3 which had the highest TVFA. TVFA in T4 was lower than other treated samples. During storage period, all yoghurt samples showed continued increase in TVFA, the increase being significant (P < 0.05) at day 7^{th} and 14^{th} for control and yoghurt supplemented linseed oil. Boycheva *et al*., (2006) had a similar observation in yoghurt .There is a positive effect of the nutrients from linseed which improve the growth of lactic acid bacteria.

Microbiological analysis:

The evolution of total bacteria counts when fresh and then after 7 and 14 days in yoghurt samples is shown in Table 4. The total plate count of bacteria for all fresh samples is significantly (P < 0.05) .Higher values were obtained for yoghurt supplemented with linseed oil compared with control samples. These results demonstrated the potential ability of linseed oil in yoghourt to enhance the microbial survival and growth.

These results agree with those of Bahagat (2010), who found that increasing of flaxseed oil percentage leads to increase in the total bacterial count of Kareish cheese significantly compared to control samples. Increasing the added percent of linseed oil in yoghurt (T4) were decreased the total bacterial count. A similar trend was found by Kankaanpää, *et al.* (2001), who showed that higher concentrations of PUFA inhibited the growth of bacteria. It is suggested that PUFA are not lethal to lactic acid bacteria but hinder the normal bacterial cell cycle. All yoghurt samples showed a marked increase in the total bacteria count on day 7 compared to fresh, indicating a significant growth activity of bacteria. On the contrary at day 14, yoghurt samples supported with linseed oil and control provided lower total count of bacteria. The observed decrease in bacteria growth could be due to the decrease in the amount of remaining sugar in yoghurt and resulting in fewer nutrients for their growth promotion (Nezhad *et al*., 2013).

Table (4). Microbiological enumeration of yoghurt supplement with linseed oil stored at 6°C for 14 days.

Components	Storage period (days)	Control	Treatments			
			T1	T2	T3	T4
Total bacterial	Fresh	2.3×10^3	2.6×10^3	2.63×10^3	2.63×10^3	2.3×10^3
	7	2.6×10^3	2.8×10^3	3.1×10^3	3.2×10^3	2.6×10^3
	14	1.9×10^3	2.1×10^3	1.9×10^3	1.1×10^3	1.1×10^3
Coliform	Fresh	ND*	ND	ND	ND	ND
	7	ND	ND	ND	ND	ND
	14	ND	ND	ND	ND	ND
Yeasts and moulds	Fresh	ND	1.4×10^2	1.4×10^2	1.3×10^2	1.1×10^2
	7	ND	6.5×10^2	4.5×10^2	4.6×10^2	1.2×10^2
	14	1.1×10^2	1.2×10^2	1.1×10^2	1.2×10^2	1.1×10^2

***ND:- Not detected**

Data presented in Table (4) shows that the total coliforms were not detected in all samples either fresh or during the cold storage period. This might be due to the severity of heat treatments of milk and the role of lactic acid bacteria in the preservation of the products and their metabolites on the growth of coliforms. These results are in agreement with those of Xu *et al.* (2008). Data illustrated in Table (4) indicated that moulds &yeasts were absent in control yoghurt when fresh and after 7 days. On the other hand, moulds & yeasts were detected in yoghurt supported with linseed oil samples initial fresh up to 14 days during of storage period. Nevertheless count of moulds & yeasts decrease with increased linseed oil concentration. Counts of moulds & yeasts were increased a maximum at day 7, then progressively decreased and reached the minimum count at the end of storage period. There were significant differences (P <0.05) in moulds & yeasts count between control and yoghurt supplementation with linseed oil. The decreased of microbial counts at the end of storage period could be due to increase the acidity during storage period. These results are in harmony with the work of Lima *et al*. (2011) who showed that the methyl esters of fatty acids are endowed with antibacterial and antifungal capacity.

Rheological properties:

Syneresis value:

Spontaneous syneresis is the expulsion of whey from yoghurt because of structural rearrangements in the gel network (Serra *et al.,* 2009). Whey separation in yoghurt is regarded as one of the crucial aspects of yoghurt texture (Lee and Lucey, 2010). As shown in Table 5, the percent of whey syneresis was higher (P < 0.05) in yoghurt fortified with different percentage of linseed oil than control throughout the storage period. Storage period had considerable effect on syneresis and the value was reduced significantly on day 14 of storage period compared to the fresh samples. The high values of syneresis can be explained by high acidity resulting in shrinkage of the protein matrix and separation of whey (Kale *et al*., 2011). However, there were significant differences in percent of whey syneresis (P < 0.05) between treatment T3 and other treatments. The decrease in the percent of whey syneresis throughout the storage period may be attributed to that at lower temperature the bonds between the particles of the gel are stronger or their numbers are greater. Also, this is because the particles are more swollen and are thereby connected to each other over a larger area (Walstra *et al*., 1999). This may be indicative of a similarity in the nature of the bonds involved in the gel structure formation of both yoghurt samples. Syneresis produced by funnel drainage does not represent the usual breakage of the yoghurt matrix, but reflects the capability of the whole gel structure to retain water (Estrada *et al.*, 2011).

Table (5). Rheological properties of yoghurt supplement with linseed oil stored at 6°C for 14 days.

Properties	Storage period (days)	Control	Treatments				Mean
			T1	T2	T3	T4	
Syneresis ratio (ml/100ml)	Fresh	39.33±.33	42.67±.33	44.00±.01	45.00±.01	41.33±.33	42.47[a]
	7	35.33±.33	37.33±.33	40.00±.01	40.67±.33	36.33±.33	37.93[b]
	14	25.33±.33	32.67±.33	35.33±.33	36.33±.33	30.67±.67	34.07[c]
	Mean	36.11[E]	37.56[C]	39.78[B]	44.00[A]	33.33[C]	
Curd tension (g/100g)	Fresh	12.33±.33	12.67±.33	14.00±.00	15.33±.33	13.33±.33	13.53[c]
	7	16.00±.58	17.67±.33	18.67±.33	18.67±.88	17.00±.57	17.60[b]
	14	22.00±.00	23.33±.33	23.67±.88	25.33±.33	24.00±.00	23.67[a]
	Mean	16.78[D]	17.89[C]	18.78[B]	19.78[A]	18.11[BC]	

[abcde] Letters indicate significant differences between Yoghurt treatments
[ABCDE] Letters indicate significant differences between storage times

There was positive relationship between the supplementation with linseed oil and the increasing rate of curd tension. The curd tension of experimental yoghurt was affected by the concentration of oil. It was nearly found that the curd tension rate increased with the increase of the ratio of oil in treatments yoghurt compared with the control yoghurt. In all treatments, curd tension increased during the storage period (Table 5). Curd tension values for control and all treatments showed a significant difference ($P<0.05$). Curd tension values are corroborated to the values reported by Ayar and Gürlin (2014). Curd tension values recorded in the present study revealed an increasing trend with increasing percentage of linseed oil which may be due to high acidity resulting in shrinkage of the protein matrix (Kale *et al*., 2011)

Organoleptic properties:

Organoleptic properties of yoghurt samples are given in Table (6). Organoleptic properties such as flavour, consistency and appearance of all types of yoghurt were evaluated after preparation and after 7 and 14 days of storage by a sensory test. Higher values were given by the panelist for the flavour, consistency and appearance of fresh control yoghurt than experimental yoghurt. As the storage period progressed the score value of all treatments were gradually decreased. At the end of storage period, control samples recorded the highest scores (83.33) followed by treatment T2 (83.0), T1 (81.67), T3 (71.67), and T4 (69.67) in order. The colour of yoghurt towards yellowness, with higher percentage of linseed oil . As well as clear sour taste with increased levels of linseed oil initial 1.5% (T3), also whey weeping increase in yoghurt supplemented with linseed oil. Fodje *et al.* (2009) mentioned that high amounts of acetate and propionate (short-chain fatty acids) resulted when flaxseed oil was fermented *in vitro*.

Table (6). Organoleptic properties of yoghourt supplement with linseed oil stored at 6°C for 14 days.

Treatment	Storage period (days)	Properties			
		Flavour (60)	Consistency (30)	Appearance (10)	Total (100)
Control	Fresh	55.00±1.00	30.00±.00	8.00±.00	93.00±1.67
	7	52.67±1.67	28.67±.33	8.00±.00	89.33±1.86
	14	51.67±1.67	24.33±.00	7.33±.33	83.33±2.03
T1	Fresh	52.67±.33	28.67±.67	8.00±.00	89.33±.33
	7	51.67±.33	27.67±.33	8.00±.00	87.33±.67
	14	50.67±.33	25.00±.00	6.00±.00	81.67±.33
T2	Fresh	50.67±1.00	28.00±.00	7.00±.00	85.67±1.00
	7	50.33±.67	26.00±.00	7.00±.00	83.33±.67
	14	50.00±.67	26.00±.00	7.00±.00	83.00±.00
T3	Fresh	49.00±.000	22.00±.00	9.00±.00	80.00±.00
	7	47.00±.00	20.33±.00	7.00±.00	74.33±.00
	14	45.00±.00	20.00±.67	6.67±.33	71.67±1.00
T4	Fresh	45.33±2.67	23.33±1.67	6.00±.00	74.67±4.33
	7	45.33±3.33	21.00±.58	6.00±.00	72.33±2.85
	14	43.00±.00	20.67±.67	6.00±.33	69.67±.58

Total scores showing high acceptability towards the flavour, consistency and appearance of yoghourt supplementation with linseed oil in both T1 and T2 treatments which were almost equally preferred compared to the control sample. Moderate amount of flaxseed oil was highly acceptable by panelists. Mainly control had the highest value followed by the treatments T2 and T1. Foda *et al.* (2012) reported that stirred yoghurt prepared from the direct addition of flaxseed to milk caused lower total acceptability scores. In general, yoghurt support with 1% linseed oil had the highest values for all sensory attributes as compared to other treatments at the end of storage period.

CONCLUSION

Flaxseed has recently gained attention as a functional food. Several flaxseed food products are now available in the market , purpose to help reduction in total blood cholesterol and low-density lipoprotein (LDL) cholesterol levels and it has being increasingly recognized for reducing the risk of cardiovascular diseases. Despite these nutritional value of linseed oil, but added with the higher ratio to milk is not positive to the degree of acceptance for the consumer. So that, this study showed that adding 1.0% to milk in the manufacture of yoghurt is best suited palatable to the consumer .Increasing the proportion of added flaxseed oil has negative an effect in the sensory properties regardless of the nutritional value. Subsequent studies are required to improve the acceptability of dairy products after flaxseed oil supplementation to milk such as adding fruits, chocolate or different kinds of flavours, stabilizer and emulsion.

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الخواص الفيزيوكيماوية والجودة الميكروبيولوجية والخصائص الحسية للزبادي المدعم بزيت بذور الكتان

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الهدف من هذه الدراسة هو دراسة تأثير اضافة زيت بذر الكتان على جودة الزبادى المصنع منه باستخدام نسب اضافات مختلفة (۰.۰، ۰.۵، ۱.۰، ۱.۵، و۲.۰٪ إلى اللبن) وذلك على الخواص الفيزيوكيماوية والجودة الميكروبيولوجية والخصائص الحسية خلال التخزين لمدة ١٤ يوما. واظهرت النتائج ان المادة الجافة والحموضة، والدهون والرماد وTVFA فى الزبادى المدعم بزيت بذر الكتان أعلى قيمة من الزبادى الكنترول والغير مدعم بزيت بذر الكتان حتى اليوم ١٤. وقد ارتفعت نسبة الدهون وقيمة TVFA بشكل واضح , ومن ناحية اخرى اظهرت عينات الزبادي المدعمة بزيت بذر الكتان انخفاضا فى قيمة pH وجاءت المعاملة T4 هى الاقل مقارنة مع عينات الزبادى الأخرى. وفى نفس الاطار ظهرت بعينات الزبادى المدعم بزيت بذر الكتان زيادة مطردة و واضحة في العدد الكلي للبكتيريا والخميرة والفطريات حتى اليوم ٧ مقارنة بالعينات الكنترول التى لم تدعم بزيت بذرة الكتان وبعدها لوحظ انخفاضا فى جميع عينات الزبادى حتى اليوم ١٤. عينات الزبادى التى دعمت بمستويات مختلفة من زيت بذور الكتان كانت أعلى في صلابة الخثرة وعدم الاحتفاظ بالشرش مقارنة بالعينات الكنترول . وأظهرت نتائج الدراسة ان هناك علاقة مباشرة بين مستويات زيت بذر الكتان المضافة وجودة الزبادي. واختلفت نتائج التقييم الحسي لكلا من النكهة والاتساق والمظهر معنويا (p< ۰.۰٥) بين عينات الزبادى , حيث ازداد لون الزبادى اصفرارا، مع الزيادة فى مستويات الاضافة من زيت بذور الكتان, وانخفاض مستوى قبول رائحة وملمس الزبادي. أخيرا، تشير نتائج هذا البحث أن الزبادى المدعم بزيت بذور الكتان عند مستوى ۱.۰٪ كان هو الأكثر قبولا.