Manufacturing of White Cheese-Like Product Using Flaxseed Oil and Skim Milk

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ABSTRACT

Milk fat has been considered as a hypercholesterolemic agent because it contains cholesterol and a generous proportion of saturated long-chain fatty acids. A nutritionally balanced product has led to the development of a choice fat source which has a critical impact on the fatty acid profile. The fortification of food with essential polyunsaturated fatty acids (PUFA), such as omega-3, is an interesting and timely topic. The health benefits associated with PUFA ingestion are several. Flaxseed oil which is rich in nutraceuticals omega-3 fatty acid has been reported to be a beneficial substitute for milk fat in some dairy products. However, a complete pilot scale research is essential to evaluate the cheese sensory properties as well as the fatty acids stability of flaxseed oil upon long-term storage. Hence, this study aimed to determine the composition and acceptability of flaxseed oil formulated reduced fat cheese with optimum levels of milk fat substituted by flaxseed oil. The control made from whole milk and two types of white cheese-like products were made from skim milk and a mixture of skim milk with flaxseed oil. Samples were subjected to (moisture, T.S, fat, protein, lactose, salt, ash, acidity (%) and pH value) and sensory evaluation in addition to microbiological content tests (total counts and coliform groups) at zero, 15, 30 and 45 days. Incorporation of flaxseed oil into cheese showed clear change in the chemical composition comparing with the control and cheese that made from skim milk except in fat content which was lower than in the control without no change in flavour and texture. However, it increased slightly the colour of cheese into yellowish and had no effect on total counts and coliform counts. Flaxseed oil incorporation also gave compatible overall acceptability as compared to the control, therefore, fortification of cheese with flaxseed oil seems ideal and consumers may enjoy the health benefits of omega-3 fatty acids with reduced-fat cheese.

Keywords: Functional food, reduced-fat cheeses, Flaxseed oil, White cheese.

INTRODUCTION

Cheese is a product of milk principally consists of fat, casein and insoluble salts, together with water in which small amounts of soluble salts, lactose and albumin are found. To retain these constituents in concentrated form, milk is coagulated either by means of lactic acid produced bacteria or by addition of rennet or both. The microflora was dominated by lactic acid bacteria (LAB) with evident mould and yeast growth (Mustafa *et al*., 2013).

Milk fat has been considered as a hypercholesterolemic because it contains around 300mg cholesterol/100g fat and a generous proportion of saturated long-chain fatty acids (Ney, 1991). Consumer demand for healthful and nutritionally balanced products has led to the development of a number of fat-free and low-fat cheese products, but flavour, texture, and shelf life of these cheeses have been optimistically described as “lacking”, “changing” or “improving “ with further research (La Bell *et al*., 1992).

In such cheese, milk fat is replaced by vegetable oils, to reduce the capital cost of production or for healthy use. In Egypt, there was fast growing in non–traditional white soft cheese in last 10 years, these cheeses containing different types of vegetable oils and different ingredients according to the manufacturers. These products do not have enough labeling information to classify these cheeses. Some of these additives cause certain defects in the flavour and consistency of cheese (Kolanowski & Laufenberg, 2006, Ye *et al*., 2009). Modification of oils and fats is possible in several ways. Rapeseed oil was modified by breeding in the 1970s to decrease the amount of erucic acid (C22:1), which is harmful to human health. It has been shown to cause morphological defects leading to harmful myocardial effects (Deshpande, 2002).

In the recent years, the number of available polyunsaturated fatty acids (PUFA) fortified foods around the world has been rapidly increased in the attempt to address this nutritional deficiency of the population. Few studies have been reported on the fortification of milk and dairy products such as yogurt and cheese (Kolanowski & Laufenberg, 2006, Ye *et al*., 2009, Bermudez-Aguirre & Barbosa-Canovas, 2011).

The health benefits associated with PUFA ingestion are several, such as reduction in cardiovascular diseases, anti-inflammatory and anti-allergic effects, development and function of the brain, retina and nervous systems, protection against certain types of cancer (Iafelice *et al*., 2008, Kolanowski & Weibbrodt, 2008). Flaxseed oil obtained from the seed of flax (*Linum usitatississimum*) is an excellent source of alpha-linolenic acid and present in high concentration (60%) of total fatty acids . An effective avenue to increase the intake of n-3 fatty acids is through the incorporation of flaxseed oil in food products. The demonstration of clinical activity associated with the consumption of flaxseed led the US National Cancer Institute (INC) to target flax as one of the six plant materials for study as cancer preventative foods. Although the physiological effect of flaxseed and its components are well known, evidence supporting and/or capitalizing on the viable market growth for functional food has not been properly documented (Oomah, 2001). Meanwhile, Kelvin *et al*. (2006) reported that the high degree of unsaturation of n-3 fatty acids means that they can become highly susceptible to rancidity, due to factors such as heat, light and oxygen, during processing and storage. A food system that is deemed to be ideal for incorporating flaxseed oil is cheese because of its low storage temperature and addition a source of vitamin E.

Flaxseed oil contains mostly of omega-3 (ALA) and partly of omega-6 (LA) fatty acids (Braun & Cohen, 2007). Human consumption of omega-3 fatty acids is proven to decrease the incidence of cardiovascular disease, reduce inflammation and prevent certain chronic diseases such as diabetes, hypertension, cancer, auto-immune diseases and arthritis (Simopoulos, 1999, Kris-Etherton *et al*., 2003, Larsson *et al*., 2004).

The present work was carried out to evaluate the capability of manufacture and acceptability of white cheese-like product made from fresh skim and flaxseed oil in comparison with the traditional white soft cheese.

MATERIALS AND METHODS

Materials

Fresh whole milk was obtained from the dairy farm belonging to Faculty of Agriculture, Alexandria University, Egypt. Fresh cold press flaxseed oil was from a private commercial flaxseed press mill at Alexandria city. Vitamin E (Purity~75%) was purchased from Al- Madina Pharmaceutical Industries. All chemicals and reagents were of analytical grade. Commercial rennet powder (microbial source), plate count agar and McConkey agar (Merck, Germany) were used in the present study.

Methods

Cheese manufacture

For the preparation of skim-milk cheese, skim milk was separated from whole milk by cream separator machine. In the present, study three cheese making trials were carried out, trial A= Skim milk, trial B= 2% Flaxseed oil + skim milk and trial C= the control cheese was manufactured from fresh whole cow's milk. In the case of the flaxseed oil-containing cheese, the skim milk was mixed separately with flaxseed oil (2%) in the presence of mono-glycerides (0.3%) as an emulsifier. Then, the mixtures were properly and individually mixed by blending machine. To remove off flavour of flaxseed oil, 1-2 drops of orange flavour were mixed per kg of skim milk during blending of the sample. All cheeses were pasteurized at 63°C for 30 min after addition of sodium chloride (3% w/w) and cooled to 40°C then calcium chloride (0.02% w/w) and rennet were added. The milk was stirred and left for 2 to 3 hr. (coagulation). When coagulation was completed, the curd was cut with the knife into small rectangular blocks (400-500 g) and transferred into clean wooden molds lined with clean cloth and pressed overnight. The collected whey of each trial was boiled (5 min) and salted (2%) for preserving the cheese samples. The resultant cheeses were evaluated for organoleptic properties when fresh comparing to the control one. Cheese samples were packed in transparent plastic film then opaque plastic containers(PP) to protect it from damage, and about 200 ml of the collected whey were added to the curd in each container. Finally, it was kept in refrigerator at 4°C for periods of 0, 15, 30 and

45 days. Chemical analysis, sensory characteristics and microbiological tests were carried out in triplicate at each storage period.

Flaxseed oil analysis

The cold pressed flaxseed oil was first degummed using 85% phosphoric acid, then neutralized with 15% sodium hydroxide, and bleached under vacuum at 90 ºC for 30 min using Tonsil ACCFF activated bleached earth as described by Lillard (1982).The cooled bleached oil was packed in brown glass bottles after adding (100 mg vitamin E /100g oil) as mentioned by Xiao *et al*. (2012) and stored at 4ºC until used. Fatty acid composition of prerefined flaxseed oil was determined as described by Radwan (1978) using Shimadzu gas liquid chromatography (GC4-CMPFE). Physical properties such as colour of oil was assessed using Lovibond Tintometer ,Model E ,100000 g,USA ,using 0.5 inch cell as described by Mackinery & Little (1962), the specific gravity at 25℃ and refractive index at 25℃ were evaluated according to (AOCS, 2001). Chemical characteristics such as saponification value (mg KOH/g oil), iodine value (wijs), free fatty acids as % oleic acid, peroxide value (PV) as milliequivalent O_2/Kg oil and acid number oil were determined according to AOCS (2001). During storage period, the oil of cheese samples were separated with Folch method (Folch *et al*.,1957) to evaluate peroxide value and the specific absorbance at 232 and 270 nm in the separated oil (Kiritsakis,1991).

Chemical analysis of milk and cheese

Whole milk and skim milk samples were analyzed for moisture, fat, protein, lactose, ash, pH values, specific gravity and acidity according to AOAC (2000). Also, cheese samples were analyzed for the moisture, T.S, fat, protein, lactose, salt, ash, acidity and pH according to AOAC (2000). All determination for milk and cheese sample were performed in triplicate.

Sensory evaluation

The sensory evaluation was carried out by a panel consisting of 10 cheese graders. Samples were presented in identical plastic sample cups sealed with plastic lids. Panelists graded cheese for flavour, taste, colour, body and texture on a 1 to 10 point scale, a score higher than 7.0 indicated high quality cheese, less than 4 indicated poor quality cheese, and between 4 and 6 indicated fair quality cheese.

Microbiological tests

Eleven grams from each cheese samples from each group were taken aseptically after 0, 15, 30 and 45 days of cold storage and weighed out and transferred to a disposable sterile plastic bag of stomacher lab blender with 90 ml of 0.1 % peptone dilution fluid (0.1 gm peptone in 100ml distilled water at pH 7) and mixed thoroughly for 30 sec to give a dilution of 1/10 . With the same pipette one mL was transferred to another dilution tube containing 9 mL of peptone water and mixed with fresh pipette. Serial dilutions of 10^{-1}: 10^{-6} were obtained by repeating the steps of mixing and transferring. Plate count agar was used for enumeration of total bacterial viable count (32℃/2 days) according to Richardson (1985). While McConkey agar was used for enumeration of coliforms (37℃/24 days) according to Lattuada, *et al*. (1998).

Statistical analysis

Data were subjected to calculation of mean and standard deveation (SD) by Microsoft office excel. The sensory evaluation data were subjected to analysis of variance (ANOVA) and multiple range test to separate the treatment means. The analysis was computed using the SAS program (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Chemical analysis of milk:

Attempts to replace milk fat with vegetable oils in the manufacture of cheeses have been made. Such substitutions could be advantageous because the vegetable oils are cholesterol-free, usually cheaper, sometimes more stable, and less subject to seasonal variation than milk fat (Kolanowski & Laufenberg, 2006, Ye *et al*., 2009).

Table (1) shows the chemical composition of whole milk and skim milk that were used in the manufacturing of the two white soft cheeses and the control.

Chemical analysis of flaxseed oil

Fatty acid composition of prerefined flaxseed oil

Polyunsaturated fatty acids in prerefined flaxseed oil represent more than 80% of total fatty acids, oleic (22.71%), linoleic (17.11%) and linolenic (40.16%) acids are the most predominant. The highest level of linolenic acid is strongly related to stability of the flaxseed oil. Xiao *et al*. (2012) stated

Table 1: Chemical composition of whole milk and skim milk sample.

Constituent	Moisture %	Fat %	Protein %	Lactose %	Ash %	pH	Specific gravity	Acidity %
Whole milk	86.10±0.03	3.5±0.01	3.42±1.01	4.7±1.02	0.75±2.01	6.66±0.02	1.03±1.03	0.17±2.01
Skim milk	87.85±1.01	0.2±0.06	4.95±0.04	4.9±3.03	0.74±1.01	6.66±0.03	1.01±0.01	0.17±1.01

Data are presented as mean ± SD.

that the totally refined and cold –pressed flaxseed oil contained oleic (20.13 and 19.05 %), linoleic (15.58 and 15.3%) acid and linolenic (55.50 and 57.44 %) acid, respectively and showed that flaxseed oil is widely accepted because of the high level of alpha linolenic acid (ALA), the precursor of n-3 long-chain polyunsaturated fatty acids. Recent researches have indicated that micronutrients in oil also exert a beneficial effect on improving lipid profile**.**

Table 2: Fatty acids composition of prerefined flaxseed oil

Fatty acids	%
Lauric acid (12:0)	0.257
Myristic acid (14:0)	0.146
Myristoliec acid(14:1)	0.570
Palmitic acid (16:0)	15.35
Palmitoleic acid (16:1)	0.037
Stearic acid (18:0)	3.08
Oliec acid (18:1)	22.71
Linoleic acid (18:2)	17.11
Linolenic acid (18:3)	40.16
Arachidoneic(20:1)	0.580
TSFA(S)*	18.83
TUSFA(U)**	80.63
U/S ratio	4. 28 : 1

* Total saturated fatty acids **Total unsaturated fatty acids

Characteristics of prerefined flaxseed oil

Table (3) shows some characteristics of prerefined flaxseed oil, used in manufacturing of cheese. Data revealed 0.910 and 1.475 for specific gravity at 25ºC and refractive index at 25°C, respectively. The colour of the oil was dark yellow and it was recorded at Lovibond apparatus as 35.0,7.0 and 4.9 yellow, red and blue, respectively. On the other hand, the chemical characteristics of the flaxseed oil revealed saponification value and iodine value of 192.42 mg KOH/g oil and 186.95Wijs, respectively. Schoene *et al.*(1998) reported that flaxseed oil possessed 0.931-0.936 specific gravity at 25˚C, 1.477-1.482 refractive index at 25˚C, 189-195 mg KOH/g oil saponification value and 165-204 (Wijs) iodine number. Table (3) shows the oil stability parameters of prerefined flaxseed oil the peroxide, free fatty acids values and acid number of oil were 2.37 meq O_2/Kg oil, 1.73 % oleic acid and 3.46, respectively. The peroxide value of the fresh extracted flaxseed oil is 0.8meq O_2/Kg oil. The Canadian Standards stated that oil considers acceptable for an edible when its peroxide value not more than 10 meq peroxide oxygen per kilogram of oil (Schoene *et al.*,1998).

Table 3: Characteristics of prerefined flaxseed oil

Characteristics	Value
Physical	
Refractive index at 25˚C	1.475
Specific gravity at 25˚C	0.910
Colour (Lovibond)	35 yellow
	7.0 red
	4.9 blue
Chemical	
Saponification value (mg KOH/g oil)	192.42±3.01
Iodine value (Wijs)	186.95±2.74
Oil stability	
Peroxide value(as meq O_2/Kg oil)	2.37± 0.55
Free fatty acids(as % oleic acid)	1.73±0.14
Acid number	3.46±0.28

Data are presented as mean ± SD.

Oxidative stability of stored manufactured white cheeses:

The Changes in peroxide value (meq O_2/Kg) and the ultraviolet specific absorbance values (K232and K270) of oil separated from the flaxseed oil based skimmed milk and whole milk cheese during storage at 4ºC were evaluated. Data in Table (4) illustrate the oxidative stability of the separated flaxseed oil, there was an increase in peroxide values as compared with whole milk cheese. Interestingly, flaxseed oil based skimmed milk cheese products were quite stable against oxidation, high lighting that the development of rancid off- flavour are expected to be very low during storage at 4°C for up 45 days. These results can be reasonably attributed to the presence of antioxidants (100 mg/100 g oil vitamin E)of flaxseed oil. The ultraviolet specific absorbance of oil estimates the conjugated hydroperoxide absorbed at 232 nm and the secondary oxidation products (aldehyde and ketones) absorbed at 270 nm. As mentioned before in Table (2), flaxseed oil rich in linoleic acid (diene) and linolenic acid (triene) exhibited high specific absorbance values for flaxseed oil separated from skimmed milk based flaxseed oil cheese compared to the oil separated from whole milk cheese in the end of storage period. Chen *et al*. (1994) found that ALA is a component in oil which is susceptible to auto-oxidation and polymerization when exposing to air or high temperature. The formation of secondary products of oil oxidation was correlated with the decrease of peroxide value (Vieira *et al*., 2001).

Chemical characteristics of manufactured cheeses

White cheese-like product was manufactured with a mixture of fresh skim milk and flaxseed oil to produce non–traditional soft white cheese similar to traditional cheese in its characteristics. The results of chemical analysis of cheeses are presented in Table (5). The total solids (TS) content ranged from 43.48 to 47.30% with average of 40.39%. Similar values were reported by Babiker (1987) but they were in contrast with those of Warsama *et al.* (2006).

The moisture contents of cheeses ranged from 52.70 to 56.52%. Changes in moisture content during storage period for 0, 15, 30 and 45 days shows that moisture content of white cheese in all samples studied were gradually increased.

The fat content ranged from o.4 to 16.8 %of total cheese weight. Generally, modified vegetable oil cheese had lower fat contents than the control cheese, but this did not seem to cause any flavour or texture defects in the cheeses. These values are lower than those reported by Elowni & Hamid (2007) and were higher than those reported by Aly & Galal (2002), who reported 18.9 ± 0.18% and12.80% values, respectively.

The protein content ranged from 16.9% to 33.9%. Changes in protein content during storage period of 0, 15, 30 and 45 days show that the protein content of cheese decreased in all samples studied. These results were higher than that reported by Aly & Galal (2002), who found a value of 13.8% and lower than those reported by Elowni & Hamid (2007).

The ash content ranged from 3.3 to 3.6%. The low ash content of pasteurized milk cheese could be explained by the diffusion of salts from the curd into the pickling solution as the result of high moisture content cheese. The aforementioned findings were in consistent with those reported by Dariani *et al.* (1980) and Ahmed & Khalifa (1989).

Lactose, salt, pH values and acidity of all cheeses were similar to those of other studies (Kleinhenz & Harper, 1997). The average salt content was 5.5%, The results in the present study were lower than those reported by Aly & Galal (2002) who reported salt of 7.24 to 8.43%. The pH values of white cheeses in samples showed decreasing

Table 4: Changes in the peroxide value (meq O_2/Kg) and ultraviolet specific absorbance values (K_{232} and K_{270})) of oil separated from the flaxseed oil based skimmed milk and whole milk cheese during storage at 4 ˚C

Cheese trials	Storage Period (days)	Peroxide value (as meq O_2/Kg)	K_{232}	K_{270}
	0	6.01±0. 1	0.080±0.2	0.080±0.03
	15	6.10±0.03	0.260±0.01	0.100±0.02
B	30	6.89±0.01	0.540±0.10	0.460±0.01
	45	7.10±0.04	0.720±0.01	0.480±0.01
	0	3.43±0.05	0.054±0.03	0.026±0.03
	15	3.75±0.01	0.091±0.05	0.080±0.04
C	30	3.81±0. 1	0.115±0.10	0.096±0.01
	45	4.01±0.03	0.220±0.01	0.150±0.10

B = Flaxseed oil based skimmed milk cheese, C= whole milk cheese.

Table 5: Chemical composition of the skim milk cheese, flaxseed oil based skim milk cheese and whole milk cheese during storage.

Storage Period (days)	Cheese trials	Moisture %	TS %	Fat %	Protein %	Lactose %	Salt %	Ash %	pH values	Acidity %
	A	53.17±0.03	46.83±0.03	0.80±0.1	33.9±0.07	2.8±0.05	5.8±0.02	3.3±0.12	6.45±0.04	0.23±0.02
0	B	52.70±0.04	47.30±0.04	9.8±0.01	25.5±0.05	2.6±0.03	5.4±0.02	3.5±0.01	6.46±0. 01	0.23±0.01
	C	52.98±0. 1	47.02±0.1	16.8±0.01	17.9±0.01	2.6±0.01	5.9±0.05	3.6±0.08	6.351±0.61	0.22±0.03
	A	53.25±0.06	46.75±0.06	0.7±0.04	33.9±0.03	2.7±0.03	5.8±0.04	3.4±0.02	6.20±0.07	0.25±0.04
15	B	54.49±0.1	45.33±0. 1	8.9±0.03	24.9±0.01	2.4±0.02	5.3±0.01	3.5±0.01	6.07±0. 01	0.33±0.01
	C	54.32±0.01	45.68±0.01	16.2±0.01	17.7±0.02	2.5±0.01	5.5±0.03	3.5±0.03	6.15±0.08	0.28±0.03
	A	54.52±0. 1	45.48±0.1	0.5±0.07	32.8±0.01	2.6±0.04	5.9±0.02	3.4±0. 1	6.02±0.07	0.28±0.05
30	B	55.97±0.04	44.03±0.04	8.1±0.05	24.3±0.01	2.3±0.01	5.5±0.01	3.4±0.03	5.86±0.06	0.43±0.01
	C	55.32±0.01	44.68±0.01	16.0±0.01	17.2±0.01	2.4±0.01	5.4±0.01	3.4±0.01	6.00±0.01	0.28±0.01
	A	55.49±0.01	44.51±0.01	0.4±0.01	32.0±0.01	2.5±0.01	5.9±0.01	3.4±0.01	6.0±0.01	0.31±0.01
45	B	56.52±0.01	43.48±0.01	7.9±0.01	23.9±0.01	2.3±0.01	5.6±0.01	3.3±0.01	5.78±0.01	0.48±0.01
	C	55.62±0.01	44.38±0.01	15.9±0.01	16.9±0.01	2.2±0.01	5.5±0.01	3.5±0.01	5.94±0.01	0.38±0.01

Data are presented as mean ± SD. A= Skim milk cheese, B= Flaxseed oil based skim milk cheese, C= whole milk cheese.

trend till the 45th day. The comparison of data of titratable acidity and microbial content shows direct relationship between microbial growth and acidity. These results agree with those obtained by Ara *et al.* (2002) and Abdel-Aty (2003).

Sensory evaluation of manufactured cheese:

The term flavour is understood as the combined sensory experience of smell and taste. Aroma is related to sensory impression of the olfactory bulb due to the volatile odorants of food and texture is related to the tactile sense, sensed either in the mouth or with fingers. The factors contributing to preference for fat are not clear. The flavour of cheese made with flaxseed oil was not apparent different from the control cheese but was better than that made from skim milk. The cheese made from flaxseed oil had higher sensory scores in volatile flavour, in agreement with Johnson (1991). No major flavour differences were found between the control cheese and the cheese made from flaxseed oil except that cheese made from flaxseed oil that rated more salty and sour. Our results are in agreement with those reported by Nour El Daim & El-Zubeir (2006). Flaxseed oil incorporation also slightly increased the acceptance level of aroma, flavour, texture and gives compatible overall acceptability as compared to the control (Table 6).

Microbial content of manufactured cheeses:

There were no observed changes in the bacterial viable count of cheese during the storage periods in the two types of cheese and the control as shown in (Table 7). The mean bacterial viable count in cheese at zero time was $3.5x10^4$. The bacterial viable count progressively increased after 15, 30 days of storage in all samples. The counts began to reduce after 45 days of storage. These results are lower than those of Ahmed (1985) who obtained

Table 6) Sensory evaluation of the skimmed milk, flaxseed oil based skimmed milk and whole milk cheese during storage.

Cheese trials	Flavour score	Taste score	Colour and Appearance score	Body and Texture score	Over all Acceptability score
A	$8.2±0.42^{b}$	$8.7±0.48^{a}$	$8.5±0.53^{ab}$	$8.1±0.32^{b}$	$8.5±0.52^{b}$
B	$8.7±0.68^{a}$	$8.8±0.42^{a}$	$8.3±0.42^{a}$	$8.8±0.42^{a}$	$8.9±0.32^{a}$
C	$8.8±0.42^{a}$	$8.9±0.32^{a}$	$8.9±0.32^{a}$	$8.9±0.32^{a}$	$9.0±0.01^{a}$

Means of 10 panelists. Data are presented as mean ± SD. A= Skim milk, B= Flaxseed oil based skim milk cheese, C= whole milk cheese.

higher total bacterial count values of 5.2x10^{8}in fresh cheese.

Table (7) shows that coliforms bacterial counts decreased gradually till day 45 of storage and the coliforms bacteria in cheese made from flaxseed oil was the highest count comparing with the other samples. The decrease in coliforms count of the cheese samples stored at refrigerator temperature from zero day to day 45 could be due to the effect of low temperature and increasing of cheese acidity. These results are in agreement with those reported by Atasever *et al.* (2003).

Table 7: Microbial content of the skimmed milk, flaxseed oil based skimmed milk and whole milk cheese during storage.

Storage period (days)	Cheese trial	Total bacterial viable count (cfug^{-1}) (PCA)	Coliforms (cfug^{-1}) (McConky agar)
	A	3.5×10^4 ±0.03	1.1 ×10^2 ±0.03
0	B	3.5×10^4 ±0.02	1.1 ×10^2 ±0.05
	C	3.5×10^4 ±0.01	1.1 ×10^2 ±0.01
	A	9.5×10^4 ±0.05	8.9 ×10^1 ±0.02
15	B	9.9×10^4 ±0.03	9.1 ×10^1 ±0.03
	C	9.2×10^4 ±0.03	8.5 ×10^1 ±0.03
	A	1.0×10^5 ±0.02	5.1 ×10^1 ±0.01
30	B	1.2×10^5 ±0.01	6.5 ×10^1 ±0.02
	C	1.1×10^5 ±0.03	5.9 ×10^1 ±0.01
	A	6.0×10^4 ±0.04	4.1 ×10^1 ±0.03
45	B	6.8×10^4 ±0.03	4.6 ×10^1 ±0.03
	C	6.5×10^4 ±0.02	3.9 ×10^1 ±0.02

Data are presented as mean ± SD. A= Skim milk cheese, B= Flaxseed oil based skim milk cheese, C= whole milk cheese.

CONCLUSION

The most important factor for a healthy fatty acid profile in diet is the choice of the fat source. The sums of saturated, monounsaturated and polyunsaturated fatty acids have been the main parameters when estimating the healthiness of particular oil. However, flavour characteristics and allergies may restrict consumption. The food industry has to consider the susceptibility to oxidation, a product's shelf life and the price of the raw material. The aim of the present study was to characterize the changes that occur in cheese formulation containing flaxseed oil and to comprise it with the control cheese (with full fat milk) and skim milk chesse. Nevertheless, dairy products with vegetable oil, it is possible to increase the healthiness of fat in the diet. Indeed, cheeses with a fat content as low as 3 %, are in the market today. Thus, reduced-fat cheeses have strong possibilities to become as appealing and accepted as full-fat cheeses.

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تصنيع الجبن الابيض باستخدام زيت بذر الكتان و اللبن الفرز

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يحتوي اللبن على نسبة من الكوليسترول و نسبة كبيرة من الأحماض الدهنية المشبعة طويلة السلسلة. لإنتاج منتجات غذائية متوازنة فإنه لابد من أخذ مصدر الدهون في الاعتبار لما له من تأثير كبير على الأحماض الدهنية. تعد اضافة الأحماض الدهنية غير المشبعة الضرورية مثل أوميجا- ٣، موضع اهتمام العديد من الدراسات في الوقت الحالي و ذلك للفوائد الصحية العديدة المرتبطة بالأحماض الدهنية غير المشبعة. ويعتبر زيت بذر الكتان المحتوي علي الأحماض الدهنية مثل أوميجا- ٣ بديلا مفيدا لدهن اللبن في بعض منتجات الألبان. ومع ذلك، فان هناك ضرورة لإجراء البحوث لتقييم الخواص الحسية للجبن الناتج ومدي ثبات الاحماض الدهنية لزيت بذر الكتان أثناء التخزين طويل الأجل. وبالتالي، تهدف هذه الدراسة إلى تحديد تركيب ومدي قبول اضافة زيت بذر الكتان في صناعة الجبن وتحديد المستويات المثلى من استبدال دهن اللبن بزيت بذر الكتان . حيث تم تصنيع نوعين من الجبن الأبيض الأول من اللبن الفرز والثاني من خليط من اللبن الفرز و زيت بذر الكتان بينما تم تصنيع الكنترول من لبن كامل . و تم تحليل عينات الجبن المصنع كميائيا لتقدير الرطوبة - الجوامد الصلبة الكلية - الدهن - البروتين - السكر - الملح - الرماد وتقدير النسبة المئوية للحموضة و أرقام الحموضة وكذلك تقويمها حسيا وإجراء الأختبارات الميكروبيولوجية لتقدير العد الكلي للبكتريا وأعداد بكتريا الكوليفورم وذلك خلال فترات التخزين وهي زمن صفر، ١٥، ٣٠، ٤٥ يوما من التصنيع وقد تم تحليل النتائج إحصائيا. واوضحت النتائج ان إضافة زيت بذر الكتان في تصنيع الجبن لم يحدث تغيراً واضحاً في التركيب الكيماوي للجبن مقارنة بالكنترول و الجبن المصنع من اللبن الفرز فيما عدا نسبة الدهن التي كانت منخفضة عن الكنترول وبدون تغير في الطعم و قوام الجبن ولكن حدث زيادة طفيفة في اللون الأصفر ولم يؤثر علي المحتوي الميكروبي وأعداد الكوليفورم وعموما فإن إضافة زيت بذر الكتان في الجبن اعطي لها قبولاً عاماً مقاربا للكنترول وعليه يمكن إضافة زيت بذور الكتان في صناعة الجبن للاستفادة من الفوائد الصحية للأحماض الدهنية أوميجا-٣ وايضا للتحصل علي جبن قليل الدسم ويمكن ان يقبل عليه المستهلك مثل الجبن كامل الدسم .