Egypt. J. Food Sci. **Vol. 45,** 1-10 (2017)

The Effect of Using Rice Bran Oil on Chemical Composition and Some Properties of Frozen Yoghurt

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THIS STUDY investigated the effect of rice bran oil (RBO) (0, 1, 2 and 3 %), on composition, some properties and sensory attributes of frozen yoghurt. The results showed that the addition of RBO improved viscosity but slightly lower overrun and melting properties when added at 3 % level. Peroxide value and thiobarabutric acid were increased during storage period. Higher levels of acetaldehyde were recorded in T2 (2%) and T3 (3%) compared with T1 (1%) of RBO. Alpha tocopherol content in T3 (3% RBO) was still greater than the other treatments. T3 contained 23.52 µg/ g alpha tocopherols after 45 days under freezing conditions. The total bacterial count ($\times 10^4$) in T1 was 3.56 in T2 was 3.53 and that of T3 was 3.58 and decreased gradually during storage. Coliforms and yeasts and molds were not found in all treatments. The flavours of all three treatments were acceptable. However, the flavours of T1 ranked 7.60 and for T2 and T3 were 7.66 and 7.68 out of 10 points respectively compared to the control (7.56) at the end of storage. On the other hand, there was difference in the scores given for the texture of the three treatments after storage (7.60; 7.63 and 7.66 out of 10 points respectively). Overall scores for body and texture suggested that addition of RBO improved textural quality, in all treatments but T3 had the highest scores. Total acceptability of samples revealed that frozen yoghurt with 3 % RBO had the most appealing sensory characteristics.

Keywords: Rice bran oil, Frozen yoghurt

Introduction

Frozen yoghurt is a frozen dessert characterized by having the texture properties of ice cream combined with the acidic taste of yoghurt. Its process consists of mixing all ingredients to make natural stirred yoghurt with stabilizers/ emulsifiers and sugar, then freezing the mix in a conventional ice cream freezer (Tamime and Robinson, 2007). Popularity frozen yoghurt has increased and continues to grow; making it one of the most frequently consumed frozen desserts around the world. Frozen yoghurt's attractiveness to consumers include providing a low fat replacement for ice cream and the probiotic benefits of the live cultures present in the yoghurt. According to Tamime and Robinson (2007), the official standard of identity for frozen yoghurt has not been specified yet in most countries. However, some references specify that the final product should have a minimum of 0.15% titratable acidity (expressed as lactic acid), >3.25% milk-fat, a pH <5, and a minimum yoghurt content >70% (Marshall *et al*., 2003). According to Taminme (2002), frozen yoghurt can be classified into three categories: soft, hard, or mousse. Soft frozen yoghurt consists of a mix of 80% yoghurt base (cold) with 20% fruit syrup base and stabilizer/emulsifier while hard frozen yoghurt is a mix containing 65% yoghurt base with 35% fruit syrup plus stabilizer/emulsifier; and mousse frozen yoghurt is a mix of the yoghurt with hot mousse base mixture (skim milk, sugar and stabilizer/emulsifier).Recently, consumers have directed their interest towards low fat frozen desserts as they associate them with a reduced risk of obesity, coronary heart diseases and diabetes. By decreasing the fat content in frozen dairy product formulation; quality attributes such as viscosity,, creaminess, melting and flavour are affected (Milani, and Coocheki, 2010).Consumers often choose to eat frozen yoghurt because they expect that it contains less lactose than ice cream with a similar amount of fat, and provides health benefits from the viable bacteria contained in it (Marshall, 2001).

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Rice bran oil (RBO) is mainly composed by triglycerides, which consist about 80% of the oil. Minor constituents of RBO are phospholipids, glycolipids, sterols and waxes. Marshall and Wadsworth (1994) recorded the composition of crud rice bran oil as follow: triglycerides are 80%, phospholipids are 2%, glicolipedes is 1% and sterols are 5% while waxes ranged from 2-5%. RBO is the most balanced and versatile oil closest to the American Heart Association recommendations (AHA, 2012). RBO has a good balance in its fatty acid composition, and it is composed mainly of oleic (37-41%), linoleic acid (37-41%) (Essential fatty acid), and palmitic acid (22-25%).Rice bran oil has natural antioxidants such as tocopherols, tocotrienols, and gamma oryzanol (Lloyd *et al*., 2000) reported presence of 19-46 mg of α-tocopherol, 1-3 mg of β-tocopherol, 1-10 mg of γ-tocopherol, and 0.4-0.9 mg of δ-tocopherol per 100 g of oil in RBO . Gamma oryzanol has been reported to be at 6.42 mg/g and 5.17 mg/g in long grain rice and medium grain rice respectively. Rice bran oil is one of the food sources with the highest phytosterols content such as γ-oryzanol, which contains 10 different compounds (esters of transferulic acid and phytosterols). Among these compounds, the major components of γ-oryzanol are cycloartenyl ferulate, 24-methylenecycloartanyl ferulate, and campesteryl ferulate. The health properties of γ-oryzanol have been studied before (El-Rahman, 2010). According to Yoshino *et al.,* (1989) γ-oryzanol health properties include a decrease of plasma cholesterol; decrease of platelet aggregation, decreased hepatic cholesterol biosynthesis, increased fecal bile acid excretion, decreased cholesterol absorption, and also γ-14 oryzanol has been used to treat nerve imbalance and disorders of menopause.

The overall objective of this study was to observe the effects of rice bran oil on the composition, characteristics and sensory properties of frozen yoghurt.

Materials and Methods

The present work was conducted in Animal Production Research Institute (APRI), Giza, Egypt. Fresh cow's milk (8.25% SNF and 2.5% fat) was obtained from the farm belonging to APRI at Sakha, Kafr El-Sheikh.

Materials

Direct Vat Starter (DVS) yoghurt culture was obtained from Chr. Hansen's Lab.,Denmark, under commercial name type (YC-X11,) containing *Streptococcus. thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus.* Commercial emulsifier-stabilizer mixes were obtained from Egyptian dairy product.Sugar was purchased from local Egyptian market.Rice bran oil (RBO) was a product of Tay-Edabil-Obil Company Bankok- Tayland.

Experimental

Preparation of yoghurt

Milk was standardized to 14 % SNF using whey protein concentrate and heated at 95 °C for 10 min, then cooled to 42 °C. It was divided into four separated portions. Control without adding rice bran oil (RBO), treatment 1 with 1% RBO, treatment 2 with 2 % RBO and treatment 3 with 3 % RBO. The treated and untreated milk samples were inoculated with 2 % starter culture and followed by incubation at 42 °C. When acidity reached 0.8 % as lactic acid, the yoghurt was cooled to refrigerator temperature (5±2 °C) and kept at the same temperature overnight.

Preparation of frozen yoghurt

To prepare the control frozen-yoghurt mix, sugar (16 %), whey protein concentrate (to adjust total solids to 30 %) and emulsifier-stabilizer mix (0.2 %) were thoroughly mixed together and dissolved in water (200 ml) and then pasteurized. The solution was added to the yoghurt (30:70), thoroughly mixed and refrigerated at 5±2 °C for 15 h. The aged frozen-yoghurt mix was frozen using a laboratory batch home ice cream maker. The resulting frozen yoghurt was filled in plastic cups (50 ml) and hardened at −18 °C. The same procedure was followed for the RBO-treated yoghurts samples described by Guner *et al*. (2007). All samples storage at -18 °C for 45 days.

Methods

Chemical analysis

The frozen yoghurt (FY) samples were analyzed for total solids, fat and total protein contents according to Ling (1963).

Titratable acidity (%), pH as mentioned by (Robinson *et al*., 1977).

The specific gravity of yoghurt ice cream mix was determined at 25ºC using pichnometer as given by Muhsenin (1978).

The overrun of frozen yoghurt was estimated using the formula of Marshal and Arbuckle

(1996).

Frozen yoghurt melting rate was determined according to Sakurai *et al*. (1996) with some modifications. The frozen yoghurt (30 g instead of 100 g, because of more melting resistance of frozen yoghurt samples) at - 18ºC was placed on a Buckner funnel at ambient temperature (25±3°C). The weight of the melted material was recorded after 15 minutes and expressed as percentage weight melted (Guner *et al.,*2007).

Peroxide value (PV) was determined to measure primary lipid oxidation products in the frozen yoghurt following the IDF method (1991).

Thiobarbituric acid (TBA) and acetaldehyde were analyzed to determine final oxidation products from the lipids in the frozen yoghurts were measured according to Robinson *et al.* (1977).

Determination of alpha tocopherol content using HPLC

The α-tocopherol concentration was determined using the method described by Jang and Xu (2009). Oils were extracted from all frozen yoghurt samples using the modified Folch extraction method (AOCS, 1997). All solvents used were HPLC-grade (Fisher Scientific). A sample (0.2 g) of oil was dissolved in 2 mL of hexane in a glass test tube and vortexed. The mixture was transferred to HPLC vials and 25 µL were injected into the HPLC system for analysis (1260 HPLC Liquid Chromatography and Waters), Bondapak C18 3.9×300 mm column. The mobile phase consisted of 0.5% ethyl acetate and 0.5% acetic acid in hexane at a flow rate of 1.5 mL/ min. The fluorescence detector was set at 290 nm excitation and 330 emissions to monitor α-tocopherol. The α-tocopherol concentration was determined and expressed as µg/ g frozen yoghurt.

Microbiological analysis

Total bacterial count (Plate count agar) and counts of Coliforms (Violet Red Bile Glucose Agar) and Yeasts and Molds (Potato Dextrose Agar contained chloramphenichole), the plates incubated at 30°C for 72 hours were done as given by Dave and Shah, (1996).

Statistical Analysis

The obtained data were statistically analyzed for variance average and Duncan's test according to SPSS computer program (SPSS, 1998).

Sensory evaluation

Ten panelists participated in a sensory evaluation of the frozen yoghurt and tested the samples. The samples were rated for colour + appearance, flavour/taste, body/texture and overall acceptance as prescribed by Herald *et al.* (2008).

Results and Discussion

Chemical properties

Table 1 shows the chemical composition of fresh and stored frozen yoghurt as affected by adding rice bran oil (RBO). Solids Not Fat (SNF) content was significantly affected by adding RBO. The recorded value in fresh frozen yoghurt (30.05%) was significantly higher ($P < 0.05$) in treatment T3 compared to the control, T1 and T2 (29.52, 29.72 and 29.86% respectively). The result of the present study is consistent with the findings of El-Owni and Zeinab (2009), who observed relatively the similar TS content of ice cream. However, Jaswinder *et al*. (2006) found a significant decrease in TS content of ice cream mix when yoghurt base was added.

Protein content in fresh frozen yoghurt was found to be slightly or not affected by adding RBO, as shown in Table 1. The highest value was recorded in the fresh frozen yoghurt made from treatment T3 (8.62%), followed by those from T2 (8.42%), T1 (8.36%) and control (8.22%) respectively. Generally, protein content was gradually decreased in all cheese samples through the storage period. The present findings are not in agreement with the results of Emata *et al*. (2001) who reported 3.72% protein content in low fat yoghurt ice cream and El-Owni and Zeinab (2009) who reported the range of protein content in between 2.49 and 2.69%. It is of interest to note that in the present study; the concentration of protein in yoghurt ice cream was remarkably higher than that of observed by the different researchers (Emata *et al*., 2001). This could be attributed to the formulation of ice cream mix and the higher SNF of used milk.

Concerning Fat content, the recorded average values of frozen yoghurt were the lowest ($P < 0.05$) in the control compared with treatments T1, T2 and T3 at the same age. However, fat content was gradually decreased during storage period in all case. The measured average values were 2.5, 3.5, 4.5 and 5.5 % in fresh frozen yoghurt, decreased to be 2.2, 3.0, 3.9 and 4.8% respectively at the end of storage period. This result is not in agreement with findings of Jaswinder *et al*. (2006) who reported 8.0% fat content in ice cream type frozen yoghurt. However, it was relatively similar in fat content to that of light class (5% fat) vanilla ice cream produced by Aimee *et al*. (2001). On the other hand, the results showed that frozen yoghurt containing 3 % RBO had significantly lower pH and higher acidity than the others ($P < 0.05$) (Table 1). The highest pH and lowest acidity value were observed in the control sample ($P<0.05$). Titratable acidity was increased and pH decreased with time after 45 days mainly due to sugar fermentation and conversion of lactose to lactic acid. Similar findings were reported Shin and Godber (1991).

Physical properties

Viscosity

Effects of different levels of RBO and storage period on viscosity are shown in Table 2. Adding RBO significantly increased viscosity compared to the control, but there was significant difference between three additions of RBO. (El-Nagar et al 2002). Akin et al. (2007) found that addition of inulin caused more viscosity in ice cream, because of the hygroscopic nature of inulin, it could bind water and form a gel-like network This increase in viscosity is related to increased protein-protein interactions and protein bonds that increase the elastic character of the gel matrix of the yoghurt (Damin et al., 2009).

Overrun

Overrun is one of the most important quality parameter of frozen desserts since it affects the texture and consequently the price of the products (Marshall *et al*., 2003). All fresh frozen yoghurt samples had overruns between 37.50-55.63% (w/w) (Table 2). Overrun depends on the amount of air trapped in frozen yoghurt and influences the quality of products (Moeenfard and Mazaheri 2008). Akin et al. (2007) found that inulin had no significant effect on ice-cream overrun. However, mentioned that addition of inulin significantly increases the overrun of ice cream (Akalin and Erisir, 2008).

Melting rate

The results showed that adding 1 % RBO had an significant effect on melting rate, but adding 2 and 3 % (RBO) prolonged the time for melting significantly ($P < 0.05$) (Table 2). The effect of

TABLE 1. Chemical analysis of frozen yoghurt as affected by using different levels of rice bran oil (RBO) and storage period (Average ± SE of three replicates)

Treatments	Property				
	SNF (%)	Protein (%)	Fat (%)	pH	Acidity (%)
Zero time					
Control	29.52±0.11 ^{d}	8.22±0.74 ^{d}	2.5±0.13 ^{d}	6.62±0.11 ^{d}	0.24±0.01 ^{a}
T1	29.72±0.06 ^{c}	8.36±0.47 ^{c}	3.5±0.14 ^{c}	6.62±0.03 ^{c}	0.24±0.03 ^{b}
T2	29.86±0.03 ^{b}	8.42±0.25 ^{b}	4.5±0.16 ^{b}	6.64±0.08 ^{b}	0.22±0.05 ^{c}
T3	30.05±0.05 ^{a}	8.62±0.36 ^{a}	5.5±0.18 ^{a}	6.68±0.06 ^{a}	0.20±0.03 ^{d}
After 15 days					
Control	28.32±0.48 ^{d}	8.06±0.47 ^{d}	2.4±0.17 ^{d}	6.41±0.19 ^{d}	0.26±0.01 ^{a}
T1	28.42±0.65 ^{c}	8.12±0.65 ^{c}	3.4±0.18 ^{c}	6.45±0.13 ^{c}	0.25±0.01 ^{b}
T2	28.66±0.85 ^{b}	8.13±0.52 ^{b}	4.3±0.19 ^{b}	6.48±0.13 ^{b}	0.24±0.03 ^{c}
T3	29.23±0.65 ^{a}	8.23±0.34 ^{a}	5.3±0.12 ^{a}	6.59±0.02 ^{a}	0.22±0.03 ^{d}
After 30 days					
Control	27.52±0.47 ^{d}	7.89±0.41 ^{d}	2.3±0.21 ^{d}	6.38±0.07 ^{d}	0.27±0.01 ^{a}
T1	27.62±0.24 ^{c}	7.82±0.21 ^{c}	3.2±0.31 ^{c}	6.39±0.06 ^{c}	0.27±0.02 ^{a}
T2	27.86±0.65 ^{b}	7.68±0.32 ^{b}	4.1±0.23 ^{b}	6.40±0.05 ^{b}	0.25±0.01 ^{b}
T3	28.43±0.31 ^{a}	7.23±0.12 ^{a}	5.1±0.42 ^{a}	6.45±0.06 ^{a}	0.24±0.03 ^{c}
After 45 days					
Control	27.12±0.25 ^{d}	7.65±0.36 ^{d}	2.2±0.22 ^{d}	6.28±0.12 ^{d}	0.24±0.05 ^{a}
T1	27.32±0.15 ^{c}	7.42±0.35 ^{c}	3.0±0.42 ^{c}	6.29±0.06 ^{c}	0.24±0.06 ^{b}
T2	27.46±0.06 ^{b}	7.32±0.24 ^{b}	3.9±0.35 ^{b}	6.30±0.09 ^{b}	0.22±0. 17 ^{c}
T3	28. 13±0.15 ^{a}	6.98±0.12 ^{a}	4.8±0.29 ^{a}	6.37±0.04 ^{a}	0.20±0. 11 ^{d}

Means ± standard error. a, b, c Means within the same column with different letters are significantly different ($P <0.05$).

TABLE 2. Viscosity, over-run and melting analysis of frozen yoghurt as affected by using different levels of rice bran oil (RBO) and storage period (Average ± SE of three replicates)

Treatments	Property		
	Viscosity (pas) at 5°C	Over-run(%)	Melting rate (%melted after 15 min at 25°C)
Zero time			
Control	0.77±0.05 d	55.63±0.97 a	78.53±0.40 a
T1	0.81±0.04 c	53.66±0.60 b	78.09±0.36 b
T2	0.82±0.04 b	51.24±0.62 c	76.25±0.16 c
T3	0.84±0.03 a	50.35±0.48 d	75.15±0.27 d
After 15 days			
Control	0.78±0.03 d	54.96±0.93 a	77.45±0.34 a
T1	0.83±0.02 c	52.36±0.60 b	76.56±0.34 b
T2	0.84±0.02 b	50.25±0.63 c	75.68±0.25 c
T3	0.86±0.01 a	48.96±0.50 d	74.88±0.44 d
After 30 days			
Control	0.80±0.02 d	52.64±0.87 a	76.44±0.41 a
T1	0.85±0.02 c	51.06±0.58 b	75.85±0.35 b
T2	0.86±0.02 b	48.03±0.60 c	75.01±0.45 c
T3	0.88±0.01 a	46.64±0.43 d	74.12±0.43 d
After 45 days			
Control	0.82±0.04 d	50.06±0.91 a	75.98±0.53 a
T1	0.87±0.03 c	48.65±0.51 b	74.95±0.20 b
T2	0.87±0.03 b	46.60±0.54 c	73.97±0.21 c
T3	0.90±0.02 a	42.06±0.47 d	73.15±0.32 d

Means ±standard error
a, b, c Means within the same column with different letters are significantly different (P<0.05).

inulin on time of first dripping was similar to that reported by Akin et al., (2007). Inulin can form a sticky network in yoghurt-ice cream that results in more resistance to melting (El-Nagar et al., 2002). The result confirmed the same for frozen yoghurt. This increase in melting time might be attributed to the lower heat-transfer rate of air trapped in the mixture (Moeenfard and Mazaheri 2008).

Alpha tocopherol content

Means and standard deviations of α-Tocopherol content during 45 days of storage of frozen yoghurt are illustrated in Table 3. Initial α-Tocopherol contents in control and the three teatments1, 2 and 3 were 0.86 ± 0. 15, 19.35 ± 1.23, 22.39 ± 2.21and 26.68 ± 1.63 µg/ g frozen yoghurt, respectively. So, addition of RBO was significantly increased the content of Vit. E in the samples. After 45 days of storage, the corresponding values were reduced to 0.72 ± 0. 23, 16.78 ± 0.39, 19.64 ± 0.33 and 23.52 ± 0.91 µg/ g, respectively.. A number of factors such as oxygen, light, heat, alkali, trace minerals, and hydroperoxides can cause decomposition of vitamin E (Bramley *et al*., 2000). The decrease in α-Tocopherol content during refrigerated storage may be primarily caused by oxygen dissolved in the yoghurt matrix, and reaction with hydroperoxides produced by initial lipid oxidation reactions.

Lipid oxidation parameters

The peroxide value (PV) was measured to determine primary lipid oxidation frozen yoghurt during storage period (Table 4). The peroxide values contents in control and the three treatments (1, 2

TABLE 3. Alpha tocopherol contents of frozen yoghurt as affected by using different levels of rice bran oil (RBO) and storage period (Average ± SD of three replicates)

Treatments	α - Tocopherol (µg/g)			
	Zero time	After 15 days	After 30 days	After 45 days
Control	0.86±0. 15 d	0.83±0. 12 d	0.77±0.02 d	0.72±0. 23 d
T1	19.35±1.23 c	19.15±0.64 c	17.83±0.65 c	16.78±0.39 c
T2	22.39±2.21 b	22.03±0.82 b	20.68±1.51 b	19.64±0.33 b
T3	26.68±1.63 a	26.32±0.93 a	25.15±1.22 a	23.52±0.91 a

Means ± standard error
a, b, c Means within the same column with different letters are significantly different (P <0.05).

&3) were 0.12±0.08, 0.15±0. 05, 0.17±0. 05 and 0.19±0.03 m mol/kg frozen yoghurt, respectively. After 45 days the corresponding values were increased to 0.19±.010, 0.20±.010, 0.23±.015 and 0.29±.020 m mol/kg frozen yoghurt, respectively. However, results indicated that there were significant differences (p <0.05) in PV between treatments of 1, 2 and 3 % during all storage times.

The formation of secondary oxidation products was determined by measuring the thiobarbituric acid (TBA). TBA of frozen yoghurt fortified with RBO is shown in Table 4. Similarly with the results for PV; TBA values were increased during storage and significant (p < 0.05) differences were found between control and treatments. Results are in agreement with those found by Tippetts and Martini (2010), who found that TBA value had a maximum increase after 72 hr storage.

Acetaldehyde content

Acetaldehyde concentrations slightly increased in control and all treatments from 6.50±0.15, 6.58±0.14, 6.63±0.05 and 6.76±0.05 (µg/mL), respectively at zero time to 6.65± 0.17, 6.74±0.12, 6.83± 0.16 and 6.94±0.33 (µg/mL), respectively after 45 days of storage. Recently, Martin et al. (2011) reported on the influence of the oxidoreduction potential value on the production of aroma compounds, as it can modify the metabolic pathways of the yoghurt bacteria. Oxidative conditions contribute to the stability of the acetaldehyde during storage of the yoghurt, whereas reducing conditions provide the opposite effect.

Microbiological examination

Survival of cultures in frozen yogurt has great importance for the healthy properties of the product (Tamime and Robinson, 1999). The addition of RBO did not affect of the total count bacterial (CFU/ g frozen yoghurt) during 45 days of frozen storage period.

Total bacterial counts ($\times 10^4$) were 3.43±0.97, 3.46±0.92, 3.53±0.46 and 3.56±0.77 CFU/g frozen yoghurt for fresh frozen yoghurt respectively (Table 5), and after 45 days storage, the counts

TABLE 4. Peroxide value (PV), Thiobarbituric acid (TBA) and Acetaldehyde content of frozen yoghurt as affected by using different levels of rice bran oil (RBO) and storage period(Average ± SE of three replicates)

Treatments	Property		
	PV (m mol/kg)	TBA (µ mol/kg)	Acetaldehyde (µg/ml)
Zero time			
Control	0.12±0.08 d	0.06±0. 05 d	6.50±0.15 d
T1	0.15±0. 05 c	0.07±0. 08 c	6.58±0.14 c
T2	0.17±0. 05 b	0.10±0.08 b	6.63±0.05 b
T3	0.19±0. 03 a	0.13±0.05 a	6.76±0.05 a
After 15 days			
Control	0.14±0. 05 d	0.07±0. 05 d	6.55±0.17 d
T1	0.16±0. 03 c	0.10±0. 08 c	6.61±0.01 c
T2	0.18±0. 03 b	0.12±0. 11 b	6.67±0. 06 b
T3	0.20±0. 08 a	0.15±0. 08 a	6.79±0. 08 a
After 30 days			
Control	0.16±0. 03 d	0.10±0. 08 d	6.61±0.01 d
T1	0.35±0.17 c	0.12±0. 06 c	6.66±0.02 c
T2	0.21±0. 08 b	0.15±0. 05 b	6.71±0.0 b 1
T3	0.24±0.04 a	0.18±0.09 a	6.84±0.01 a
After 45 days			
Control	0.19±.010 d	0.12±0.08	6.65±0. 17 d
T1	0.20±.010 c	0.16±0. 08 c	6.74±0. 12 c
T2	0.23±.015 b	0.18±0. 05 b	6.83±0. 16 b
T3	0.29±.020 a	0.20±0. 08 a	6.94±0. 33 a

Means ±standard error
a, b, c Means within the same column with different letters are significantly different (P <0.05).

were 1.36±0.50, 1.40±0.72, 1.46±0.50 and 1.56±0.72 CFU/g respectively. Such results are in agreement with those obtained by Estrada, (2011), who found that the addition of microencapsulated menhaden oil and microencapsulated salmon oil had no effect on LAB counts of yoghurts during 4 weeks of storage. Lopez et al. (1998) studied the survival of LAB (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) in commercial frozen yoghurt stored for 60 weeks at -23 °C. They reported initial counts of 7.57-7.58 and 4.29-6.79 log CFU/g for *Streptococcus. thermophilus* and *Lactobacillus bulgaricus* respectively and found that LAB remained stable during storage and concluded that the shelf life period could be prolonged beyond 60 or 67 weeks.

Coliform bacterial count (CBC) was not detected in control frozen yoghurt from the control and all treatments. On the other hand, yeasts and molds were not also detected during storage period (Table 5).

Organoleptic properties

Table 6 shows mean sensory scores of overall sensory attributes of the control and three treatments of frozen yoghurts. According to acceptability of each group, there was a difference in the mean scores of flavour, body& texture, colour & appearance, and the overall acceptability among the control and the three treatments. The flavour of T1 ranked 7.79 and for T2 and T3 were 7.82 and 7.89 (out of 10 points) respectively compared to control (7.73). On the other hand, there were differences in the body and texture scores of the three treatments (7.80, 7.83 and 7.90 respectively) compared to control (7.70). Overall scores for body & texture suggested that addition of RBO were better in improving textural quality. Overall scores for T 2 and T3 ranged from 7.82 to 7.89 (out of 10 points) respectively, which were equivalent to very good on the sensory scale. No serious body & texture defects were detected by the panelists in all treatments but T3 was more acceptable. The colour of the frozen yoghurt was as natural and good appearance. Such observations were recorded for the fresh product but gradually changed with very slight rate during storage suggesting good quality for the product at the end of storage period.

TABLE 5. Total bacterial count (TBC), coli form and molds & yeasts of frozen yoghurt as affected by using different levels of rice bran oil (RBO) and storage period(Average ± SE of three replicates)

Treatments	TBC ×10^4 (cfu/g)	Coli form ×10^2 (cfu/g) **	Molds and yeasts×10^2 (cfu/g)**
Zero time			
Control	3.43±0.97 ^{d}	ND	ND
T1	3.46±0.92 ^{c}	ND	ND
T2	3.53±0.46 ^{b}	ND	ND
T3	3.58±0.77 ^{a}	ND	ND
After 15 days			
Control	3.40±0.60 ^{d}	ND	ND
T1	3.44±0.53 ^{c}	ND	ND
T2	3.50±0.58 ^{b}	ND	ND
T3	3.54±0.66 ^{a}	ND	ND
After 30 days			
Control	2.38±0.58 ^{d}	ND	ND
T1	2.42±0.58 ^{c}	ND	ND
T2	2.63±0.31 ^{b}	ND	ND
T3	2.66±0.58 ^{a}	ND	ND
After 45 days			
Control	1.36±0.50 ^{d}	ND	ND
T1	1.40±0.72 ^{c}	ND	ND
T2	1.46±0.50 ^{b}	ND	ND
T3	1.56±0.72 ^{a}	ND	ND

Means ±standard error

a, b, c Means within the same column with different letters are significantly different (P <0.05).

**ND= not detected.

TABLE 6. Sensory evaluation of frozen yoghurt as affected by using different levels of rice bran oil (RBO) and storage period (Average ± SE of ten panelists)

Treatments	Flavour (10 points)	Body&Texture (10 points)	colour & appearance (10 points)	Overall acceptance (10 points)
Zero time				
Control	7.73±0.03 d	7.70±0.05 d	7.70±0.05 d	7.73±0.07 d
T1	7.80±0.05 c	7.80±0.08 c	7.76±0.08 c	7.79±0.09 c
T2	7.82±0.03 b	7.83±0.03 b	7.80±0.05 b	7.82±0.06 b
T3	7.90±0.05 a	7.90±0.05 a	7.86±0.08 a	7.89±0.09 a
After 15 days				
Control	7.73±0.03 d	7.70±0.05 d	7.66±0.05 d	7.66±0.05 d
T1	7.76±0.05 c	7.73±0.03 c	7.70±0.10 c	7.74±0.10 c
T2	7.74±0.04 b	7.73±0.08 b	7.70±0.10 b	7.70±0.10 b
T3	7.86±0.06 a	7.80±0.05 a	7.76±0.0 a 5	7.69±0.05 a
After 30 days				
Control	7.66±0.03 d	7.63±0.03 d	7.63±0.03 d	7.64±0.03 d
T1	7.66±0.03 c	7.63±0.06 c	7.63±0.06 c	7.64±0.06 c
T2	7.70±0.05 b	7.66±0.06 b	7.66±0.06 b	7.67±0.06 b
T3	7.70±0.05 a	7.66±0.03 a	7.66±0.03 a	7.67±0.03 a
After 45 days				
Control	7.56±0.06 d	7.56±0.03 d	7.53±0.03 d	7.55±0.03 d
T1	7.60±0.05 c	7.60±0.05 c	7.60±0.03 c	7.60±0.05 c
T2	7.66±0.03 b	7.63±0.03 b	7.62±0.03 b	7.63±0.03 b
T3	7.68±0.03 a	7.66±0.03 a	7.64±0.05 a	7.66±0.03 a

Means ±standard error

a, b, c Means within the same column with different letters are significantly different (P <0.05)

Conclusions

The results of the present study suggested that adding rice bran oil (RBO) had significant impacts on frozen yoghurt composition and quality. As the ratio of adding RBO increased, the properties were improved. Frozen yoghurt made from treatment three of adding 3 % RBO had superior flavour, body and texture, colour and appearance when compared with all treatments.

Referances

Aimee, D.B.; Arntfield, S.D. ; Malcolm, L.J. and Ryland, D. (2001) Textural analysis of fat reduced vanilla ice cream products. *Food Res. Int.,* **34,** 237-246.

American Oil Chemists Society (1997) *Sampling and Analysis of Commercial Fats and Oils. Official Method* Cd 18-90, p-Anisidine Value.

American Heart Association (2012) Fats & oils: Fats 101. http://www.heart.org/HEARTORG/GettingHealthy/FatsAndOils/Fats101_UCM_304494_*Article.jsp Accessed March* **15,** 2012.

Akalin, S. and Erisir, D. (2008) Effects of inulin and oligofructose on the rheological characteristics and probiotic culture survival in low fat probiotic ice cream. *J. Food Sci* **73,**184–188.

Akin, M.B., Akin, M.S. and Kirmac, Z. (2007) Effects of inulin and sugar levels on the viability of yogurt and probiotic bacteria and the physical and sensory characteristics in probiotic ice-cream. *Food Chem.* **104,**93–99.

Bramley, P.M., Elmadfa, I., Kafatos, A., Kelly, F.J.; Manios, Y., Roxborough, H.E.; Schuch, W.; Sheehy, P.J.A.. and Wagner, K.H. (2000) Review vitamin E. *J. Sci. Food and Agric.* **80,** 913–938.

Damin, M. R., Alcantara, M. R., Nunes, A. P. and Oliveira, M. N. (2009) Effects of milk supplementation with skim milk powder, whey protein concentrate and sodium caseinate on acidification kinetics, rheological properties and structure of nonfat stirred yogurt. *LWT-Food Sci. and Techno.* **42,** 1744-1750.

Dave, R. and Shah, N. (1996) Viability of Yoghurt and Probiotic Bacteria in Yoghurts Made from Commercial Starter Cultures. *Int. Dairy J.*l.**7,** 3141.

El-Nagar, G., Clowes, G., Tudorica, C.M. , Kuri, V.

and Brennan, C.S. (2002) Rheological quality and stability of yog-ice cream with added inulin. *Int. J. Dairy Techno.,* **55,** 89-93.

El-Owni, O.A.O. and Zeinab, K.O.K. (2009) Chemical composition of ice cream produced in Khartom State. *Sudan. Pak. Nutr.*, **8**-158-160.

El Rhaman, S. (2010) Extraction and separation of γ-oryzanol from rice bran oil by HPLC and studying its effect on rats fed a high-cholesterol diet. *International Journal of Food, Nutrition and Public Health.* **3,** 119-132.

Emata, O.C., Dulay, T.A. , Resubal, L.E. and. Sanchez, P.C. (2001) Low-fat yoghurt ice cream: Effect of incubation period on the chemical, microbiological and sensory qualities. *Philip. J. Crop. Sci.,* **27,** 45.

Estrada, J. (2011) Production and processing of a functional yogurt fortified with microencapsulated omega-3 and vitamin E (*Master's Thesis*). Retrieved from Louisiana State University. ETD-06282011-144209. 54-57.

Guner, A., Ardic, M.; Keles, A. and Dogruer, Y. (2007). Production of yoghurt ice cream at different acidity. *Int. J. Food Sci. Technol.,* **42,** 948-952**.**

Herald, T. J., Aramouni, F. M. and Abu- Ghoush, M. H. (2008) Comparison Study of Egg Yolks and Egg Alternatives in French Vanilla Ice Cream. *J. Texture Stud.,* **39:** 284- 295.

International IDF Standards. (1991) International Dairy Federation, IDF-Square Vergote **41,** Brussels, *Belgium, sec.* 74A:1991.

Jang S. and Xu, Z. (2009). Lipophilic and hydrophilic antioxidants and their antioxidant activities in purple rice bran. *J. Agric. Food Chem.* **57:** 858–862.

Jaswinder, S., Minhas, K.S. and Usha, B. (2006) Studies on preparation and shelf-life of yoghurt ice cream. *J. Food Sci. Techno.*, **43,** 656-661.

Ling, E. R. (1963) *A Text-Book of Dairy Chemistry.* Vol.2, Practical, 3rd ed., Champan and Hall, London, England.

Lloyd, B. J. Siebenmorgen, T. J. and Beers, K. W. (2000) Effects of commercial processing on antioxidants in rice bran. *Cereal Chem*. **77**(5), 551-555.

Lopez, M. C., Medina, L. M. and Jordano. R. (1998) Survival of lactic acid bacteria in commercial frozen yogurt. *J. Food Sci.* **63,**706–708.

Marshall, R.T. (2001) Frozen dairy dessert. In: Marth EH, Steele JL (Ed) *Applied Dairy Microbiology.* Deeker Press, New York, 93–127.

Marshall, R. T., Goff, H. D. and Hartel, R. W. (2003) *Ice Cream.* 1st ed.; Aspen Publishers, New York,.

Marshall, W. E. and Wadsworth, J. I. (1994) *Rice Science and Technology,* 1st ed.; Marcel Dekker: NY.

Marshal, R. T. and Arbukle, W. S. (1996) Formulas and Industry Standards: *Ice Cream.* (Ed.): Arbukle, W. S., 5th ed., Chapman and Hall, New York, PP.314-327.

Martin, F., Cachon, R., Pernin, K., De Coninck, J. , Gevais, P., Guichard, E. and Cayott, N.(2011) Effect of oxidoreduction potential on aroma biosynthesis by lactic bacteria in nonfat yogurt. *J. Dairy Sci***. 94,**614–622.

Milani, E. and Coocheki, A. (2010) The Effects of Date Syrup and Guar Gum on Physical, Rheological and Sensory Properties of Low Fat Frozen Yoghurt Dessert. *Int. J. Dairy Technol.* **64,** 121-129.

Moeenfard M. and Mazaheri Tehrani M. (2008) Effect of some stabilizers on the physicochemical and sensory properties of ice cream type frozen yogurt. *Am Eurasian J. Agric. Environ. Sci.* **4,**584–589.

Muhsenin, N. N. (1978) *Physical Properties of Plant and Animal Materials.* Gorden and Breach Science Publishers, New York, 101. Muhsenin, N. N. 1978. Physical Properties of Plant and Animal Materials. Gorden and Breach Science Publishers, New York, 101PP.

Robinson R.K., Tamime, A,Y. and Chubb, L.W. (1977) Acetaldehyde as an indicator of flavour intensity in yoghurt. *Milk Ind.,* **79,** 4-6.

Sakurai, K., Kokubo, S., Hakamata, K., Tomita, M. and Yoshida, S. (1996) Effect of production conditions on ice cream melting rate and hardness. *Milchwissenchaft,* **51,** 451–454.

Shin, T.S. and Godber, J.S. (1991) Changes of endogenous antioxidants and fatty acids composition in irradiated rice bran during storage. *J. Agric. Food Chem.* **4412,** 567-573.

SPSS (1998) Statistical Package for Social Scince. SPSS Inc. Chicago, Illions, USA.

Tamime, AY. (2002) Fermented milks: a historical food with modern applications – a review. *European J. of Clinical Nutrition,* **56,** 2- 15.

Tamime, A.Y. and Robinson R.K. (1999) Historical Background In: *Yoghurt: Science and Technology* (Ed.: AY Tamime and RK Robinson). 2nd ed. CRC Press, Boca Raton, FL. 7-8.

Tamime, A.Y. and Robinson R.K. (2007) *Background, standards and marketing of frozen yogurt: Yoghurt: Science and Technology* (Ed.: AY Tamime and RK Robinson). 3rd ed. CRC Press, Boca Raton, FL. p. 392-393.

Tippetts, M. and Martini, S. (2010) Evaluation of flavor characteristics of docosahexaenoic acid-fortified emulsions as a function of crystallization temperature. *Food Chem.* **122,**737–43.

Yoshino, G., Kazumi, T., Amano, M., Tateiwa, M., Yamasaki, T., Takashima, S., Iwai, M., Hatanaka, H. and Baba, S. (1989) Effects of gamma-oryzanol and probucol on hyperlipidemia Current *Therapeutic Res.* **45,** 975-982.

(*Received:*9/11/2016;
*accepted:*10/7/2017)

دراسة على تاثيرزيت نخالة الارز على التركيب الكيماوى و بعض خواص اليوغورت المجمد

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تهدف هذه الدراسه الى دراسه تاثير اضافه زيت نخاله الارز بنسب صفر, ١, ٢ , ٣٪ الى اليوغورت المستخدم فى صناعه اليوغورت المجمد وتاثير ذلك على الخواص الفيزيائيه و الكيماويه والحسيه للمنتج.

واظهرت النتائج ان اضافه زيت نخاله الارز بنسبه ٣٪ قد ادت الى انخفاض تدريجى لكل من الريع ودرجه الانصهار وحسنت من اللزوجه لليوغورت خلال فتره التخزين(٤٥ يوم). و من ناحيه اخرى زاد رقم البيروكسيد وحمض الثيو باربيوتيرك خلال فتره التخزين(٤٥ يوم). فى حين كان اعلى مستوى من الاسيتالدهيد فى المعامله الثانيه و الثالثه مقارنه بالمعامله الاولى وذلك راجع الى النشاط السريع للبادىء.بينما احتوت المعامله الثالثه(٢٣,٥٢) على اعلى مستوى من الفا تو كوفيرول فى نهايه فتره التخزين (٤٥ يوم) مقارنته بالمعامله الاولى و المعامله الثانيه. بينما كان العد الكلى للبكتيريا (×١٠٤) ٣,٥٦, ٣,٥٣ و ٣,٥٨ فى المعامله الاولى و الثانيه و الثالثه على التوالى مقارنه بالكونترول (٣,٤٣). العد الكلي للبكتيريا في كل المعاملات انخفضت تدريجيا أثناء التخزين.فى حين لم يتم العثور على بكتيريا القولون و الفطريات و الخمائر في كل المعاملات. وكان التقييم الحسى للنكهه مقبول فى كل المعاملات بينما كانت المعامله الاولى ٧,٦٠ و المعامله الثانيه ٧,٦٦ المعامله الثالثه ٧,٦٨ مقارنه بالكونترول ٧,٥٦ . من ناحيه اخرى كان هناك اختلاف فى التركيب فى المعاملات الثلاثه (٧,٦٠و ٧,٦٣ و٧,٦٦ على التوالى) فى حين حاز الكونترول على ٧,٥٥ درجه من ١٠ درجات فى نهايه فتره التخزين.و تشير النتائج الى ان اضافه زيت نخاله الارز قد حسنت من النكهه و القوام والتركيب لليوغورت المجمد بينما كانت المعامله الثالثه هى الافضل على الاطلاق.