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STUDIES ON THE PHYSICOCHEMICAL CHARACTERISTICS, MICROBIAL LOAD AND STORAGE STABILITY OF OIL FROM INDIAN ALMOND NUT (*TERMINALIA CATAPPA L.*)

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Abstract

Oils constitute one of the essential components of balanced diet as good source of energy, as well as complementing the energy needs of the society in the form of biodiesel. The chemical and physical properties of oils are amongst the most important properties that determine the quality and help to describe the present condition of oils. The physicochemical characteristics, microbial load and storage stability of Indian almond (*Terminalia catappa*) seed oil collected in Cape Coast, Ghana were investigated and compared with that of frytol vegetable oil manufactured by a leading manufacturing industry in Ghana. The seed recorded a good yield of 52.11% oil. The mean physicochemical parameters of the almond nut oil were:- specific gravity (0.923), refractive index (1.465), moisture content (0.550%), insoluble impurities (0.133%), free fatty acid (0.38%), and peroxide, iodine, acid and saponification values were (4.073 meq/kg), (121.19 wijs), (0.78 mgKOH/g), (168.27 mgKOH/g) respectively. All the physicochemical parameters determined were significantly ($p<0.05$) higher than those determined for frytol. Storage stability of both oils under room temperature showed faster deterioration of oils when exposed to daylight than when stored in darkness. The mean free fatty acid values (oleic acid) obtained for both oils when exposed to light and darkness respectively throughout the period of study (2 months) were 0.585% and 0.490% for almond and 0.585% and 0.260% for frytol. Similarly, the mean peroxide values were 25.670 and 19.15meq/Kg for almond and 15.115 and 12.95meq/Kg. There were no detections for *Salmonella* in both oil samples. However, there were detections for fungi in both oils with mean counts of 1.4 x 10^3cfu/ml for almond and 1.3 x 10^3cfu/ml for frytol. The mean mesophilic counts for almond and frytol were 4.0 x 10^3cfu/ml and 4.8 x 10^3cfu/ml respectively. The physicochemical properties of the almond seed oil indicated that it is edible, drying and suggested its suitability for industrial purposes as well as the nutritional potentials of the nut, which could serve as an alternative food ingredient for unsaturated vegetable oil.

Keywords: Physicochemical parameters, almond nut oil, frytol, shelf life, microbial load

1. Introduction

Fats and oils whether the source is animal, vegetable or marine in origin represent the highest source of energy per unit weight that man can consume. Apart from being a source of reserved energy, fats deposit insulates the body against loss of heat and protects vital organs against mechanical injury. They are important food source for man, and are also extensively used for nutritional, cosmetic, drug dispersant in therapeutics and industrial purposes and are used for supplying essential fatty acids such as linoleic and arachidonic acids (Rauken and Kill, 1993).

Oils from nut are both edible and non-edible depending on the type. These oils are often available as raw materials for chemical and industrial applications. Nuts provide an interesting nutritional supply due to their high nutritive and energetic value. However, their high fatty content makes them unattractive for new consumers demanding “light”, low-fatty foods. Among nuts, almonds have a significant economical importance.

Terminalia catappa is a large tropical tree in the Leadwood tree family, Combretaceae (Combretum). Tropical almond (*Terminalia catappa*) is a spreading tree now distributed throughout the tropics in coastal environments. Currently, Tropical almond has been introduced, and frequently naturalized, in many tropical parts of the world including Brazil, the Caribbean, and East Africa (Thomson and Evans, 2006). The nut within the fruit is edible when fully ripe, tasting almost like almond. The kernel of Indian almond has shown aphrodisiac activity; it can probably be used in treatment of some forms of sexual inadequacies (premature ejaculation). Extracts from the leaves and bark of the plant have proven anticarcinogenic, anti-HIV and hepatoprotective properties (liver regenerating effects), including anti-diabetic effects.

Due to lack of indepth information on the nutritional potential of almond nuts in Ghana currently, a lot of people (mostly children) eat the almond fruit without knowing the nutritional benefits and products that can be obtained from the nut. Furthermore, due to a high demand for vegetable oils in view of the population growth, rising

standards of living as well as consumer preference, arising partly from health considerations (Oresanya, 2000), there is need to evaluate many other seeds for oil production.

Almond nut oil is reported as a possible source of nutritional oil (Agunbiade and Olanlokun, 2006). This is recently receiving much interest due to its many attributed beneficial effects, such as its ability to lower cholesterol specifically by reducing low-density lipoprotein (LDL) cholesterol, while preserving the beneficial high-density lipoprotein (HDL) (Lovejoy *et al.*, 2002).

Information abounds on the nutritional content of common nuts such as groundnut, pea nut, cashew nut, walnut etc. However, there are limited information on the nutritional composition, utilization and physicochemical properties of the almond nut oil in this part of our world, Ghana. The study is aimed at assessing the microbial quality, storage stability as well as the physicochemical characteristics of almond nut oil produce in Ghana. Such information will expand the scope of knowledge on the utilization of almond oils in various food and nutritional applications and storage qualities and to bring together data to support the uses, health and economic benefits of the almond nut that is completely unexploited in Ghana.

2. Methodology

2.1 Sample collection technique and preparation

The Indian almond fruits were collected between December and January, 2011 from Cape Coast in the Central region of Ghana. In all, about two thousand almond seeds were obtained on daily bases from fully ripe fruits that fell to the ground for a period of three weeks. The edible portion was manually removed leaving the stony shell containing the nut. The seeds were carefully cracked to remove the groundnut-like nut which were dried under the sun for two weeks. The dried samples were then milled using a blender to produce a powder that was stored in airtight plastic container at 4°C in a refrigerator until required for extraction and analysis. Also, a bottle of refined palm oil (frytol) was purchase from the market in Cape Coast as control.

2.2 Extraction of the oil

The extraction of the oil from the seeds was carried out in a Soxhlet apparatus fitted with a 2 L round bottomed flask (Rashid et al., 2008) using analytical grade petroleum ether (B.P 40-60°C) as refluxing solvent. The solvent was removed under vacuum, using a rotary evaporator. Further evaporation of residual solvent was done on water bath (AOAC, 1990).

The amount of oil extracted was determined using the equation :

Oil content (%) = weight of oil extracted / weight of seed × 100

2.3 Determination of the Physicochemical Characteristics of the oils.

The extracted oil was immediately analyzed for chemical properties, such as: iodine, peroxide, acid and saponification value, while specific gravity, viscosity refractive index and colour were examined for the physical properties. Estimation of the percentage free fatty acids as oleic acid was done, following the method of Cocks and Rede (1998). The refractive indices of the oils (at room temperature) were determined with Abbe refractometer (Alamu et al., 2008) and the specific gravity measurement (also carried out at room temperature), using specific gravity bottle (Oderinde et al., 2004). The state and colour of the oil were noted, using visual inspection at room temperature (Oderinde et al., 2009). Viscosity and yield were determined, following the method described by the Association of Official Analytical Chemists (AOAC) (1984). Results are expressed as the means of three separate determinations

(3)

2.4 Shelf life stability

Storage conditions

Oil samples were transferred to transparent plastic containers. The containers were closed and subjected to different storage conditions: (i) at room temperature with exposure to daylight and (ii) at room temperature in darkness. Periodically (every week) a suitable volume of oil was withdrawn from each container and subjected to the Kreis test and to the determination of peroxide and free fatty acid value for a period of two months. In the months (February and March) the room temperature varied between 25°C and 30°C. The oil samples exposed to daylight were placed approximately 1.5cm from the window and those kept in the dark were placed in the laboratory cupboard and the locker closed. The intensity of light in the room depended on the weather conditions.

Rancidity index

Two milliliters (2ml) of the sample was shaken vigorously with 2ml of 0.1% phloroglucinol solution in ether and 5mls of conc. HCl for 20seconds. When a pink colour occurred, it indicates rancidity (Kirk and Sawyer, 1991).

2.5 Microbial analysis

Total Mesophilic Count of the Samples

A stock solution of each of the samples was made by dissolving one millilitres (1ml) of each sample in nine millilitres (9ml) of sterile Tween 80. Three – fold serial dilution was made from each stock solution. Aliquots of the last two dilutions of each sample were inoculated on Plate Count agar (PCA) and Salmonella, Shigella agar in duplicates using the pour plate method. The raw sample was also inoculated onto the Salmonella, Shigella agar using the spread plate method. All the plates were incubated at 37°C for 24 hours. Colonies were counted after 24 hours and results expressed as colony forming units per millilitre. However for salmonella, detections were made (Okechalu *et al.*, 2011).

Yeast and Moulds

A stock solution of each of the samples was made by dissolving one millilitres (1ml) of each sample in nine millilitres (9ml) of sterile Tween 80. Three – fold serial dilution was made from each stock solution. Aliquots of the last two dilutions of each sample was inoculated on Sabauraud's Dextrose Agar (SDA) and incubated at room temperature in a canister for 7 days. Colonies were counted after 7days and results expressed as colony forming units per millilitre
(Okechalu *et al.*, 2011).

3.0 STATISTICAL ANALYSIS

All the experiments were performed in triplicate and the results were expressed as mean ± SD (standard deviation). Statistical comparisons were performed using Analysis of Variance (ANOVA), SPSS 17.0. Differences were considered significant at $p<0.05$.

4.0 **Result and Discussion**

The Almond nut is a small portion of the fruits and the determination by solvent extraction yielded an oil content of 52.11%. The results of the chemical properties of the two studied oils (Almond and frytol) are presented in Table 1. At room temperature (28 ±3°C), all the oils were liquids. Colours of the oils were golden yellow. The analyses revealed marked variations in the peroxide values (PV), free fatty acids (FFA), and Iodine values (IV), Saponification values (SV) and Acid values (AV).

Levels of unsaturation in the almond and frytol oils were different since they registered approximately different mean iodine values at relatively high side of 121.19 for almond and 35.18 for frytol which is less than 100. The iodine value is an identity characteristics nature of oil. It indicates the degree of unsaturation in the fatty acid of triglyceride**.** This value could be used to quantify the amount of double bond present in the oil which reflects the susceptibility of oil to oxidation. Almond oil has a significantly ($P<0.05$) higher iodine value than that of the frytol oil. High iodine value indicates high unsaturation of fats and oils and low-IV oils are more saturated with fewer double-bonds (Knothe, 2002; Kyriakidis and Katsiloulis, 2000). The values obtained here suggested that the oil is highly unsaturated and may be susceptible to rancidity. Also higher iodine values are evidence that the oils could be used in the manufacture of cosmetics, oil paints and vanish, as well as nutritional purposes. According to Guyton and Hall (2000), accumulation of excessive iodine in the body could lead to development of goiter and the enlargement of the thyroid gland (Guyton and Hall, 2000).

The iodine value obtained is high >100 suggesting the presence of unsaturated fatty acids and this places the oil in the drying groups as drying oils have an iodine value above 100 (Duel,1951). The iodine value is higher than typical iodine values obtained for coconut oil (25-40), palm oil (37-54), olive oil (75-95) and peanut oil (85-100). However, it falls within the range of typical iodine values for corn oil (115-130) and fish oil (120-180) rich in omega-3-fatty acids. This value is in sharp contrast to the value obtained by Olatidoyi et al. (65) (2010) for the almond nut oil collected in Nigeria which classified the oil as non-frying oil.

Table 1: Chemical qualities of almond and frytol oils

Oil name	Col.	State (28±3° C)	FFA (% OA)	AV (mgKOH/g)	PV (meq/Kg)	SV (mgKOH/g)	IV (wijs)
Almond	Golden	Liquid	0.387±0.00	0.787±0.00	4.073±0.11	168.27±0.059	121.19±0.01
Frytol	Golden	Liquid	0.227±0.006	0.536±0.006	6.327±0.006	92.15±0.017	35.237±0.071
Std.				<4.0	< 10		

Values are means of triplicate determinations with standard deviation. Std = Standard value.
NB. FFA = Free fatty acid, AV= Acid value, PV= Peroxide value, SV= Saponification value, IV= Iodine value.
There is a significant ($p<0.05$) difference between parameters of almond and the frytol oil values at 95% confidence limit.
The mean acid value of the almond and frytol were 0.787 mg KOH/g and 0.535 mg KOH/g respectively. The acid value of the frytol oil is significantly *(P<0.05)* lower than those values of the almond oil. This may be due to the variation in the moisture contents, refining and deodorization processes used in the production of the frytol oil. The acid value of the nut is lower when compared with cashew nut oil (0.82mgKOH/g) (Aremu et al, 2006a), palm oil (14.04mgKOH/g) (Akubugwo and Ugbogu, 2007). Pearson (1976) reported acid values of sesame, soybean, sunflower and rape seed of 7 mg KOH/g.
Results obtained from this work indicated that the acid value of the oil corresponds to low levels of free fatty acids present in the oil, which also suggested low levels of hydrolytic and lipolytic activities in the oils. Acid value represents free fatty acid content due to enzymatic activity and is usually indicative of spoilage. Acid value is used as an indicator for edibility of oil and suitability for use in the paint industry The maximum acceptable level is 4mgKOH/g oil (Codex Alimentarius, 1992), for recommended international standards for edible Arachis oil below which the oil is acceptable for consumption. Since the acid value of the almond is lower than the maximum permissible acid level of 4mgKOH/g fat or oil required for edible virgin fats and oils, the almond nut oil is suitable for direct consumption. The oil therefore requires no refining processes to improve its quality for industrial purposes.
Saponification is the process of breaking down a neutral fat into glycerol and fatty acids by treatment with alkali. The saponification number is defined as the mg of KOH required to saponify one gram of fat. High saponification value shows that more alkali would be required to effect neutralization of the available free fatty acid librated by the oil.
The oils contain mean saponification values of 168. 27mgKOH/Kg and 92.15 mgKOH for almond and frytol oils respectively. This value is greater than what recorded by Olatidoye et. al (2010) but lower than saponification values for some vegetable oils cited in literature. For instance, Kyari (2008) reported that SV for palm oil is 200 (mg KOH/g sample), for groundnut is 193 (mg KOH/g sample) and for coconut oil is 257 (mg KOH/g sample). Saponification values had been reported to be inversely related to the average molecular weight of the fatty acids in the oil fractions (Abayeh and Okuonghae 1998). Since high saponification values of fats and oils are due to the predominantly high proportion of shorter carbon chain lengths of the fatty acids (Kirk and Sawyer, 1991), it implies that the almond oil has high proportion of shorter carbon chains than the frytol oil. Saponification value is used in checking adulteration. The high saponification values recorded for the almond seed oil suggests low level of impurities. The almond oil could therefore be useful industrially for soap, shampoo and paints making (Kirschenbaucr, 1965; Akanni *et al*, 2005; Sabinus, 2012).
The peroxide value is defined as the weight of active oxygen contained in one gram of oil of fat (Horwitz, 1975). It therefore determines the degree of oxidation of oil as well as gives an indication of the level of deterioration of oils and fats (Okechalu et al., 2011).
Fresh oils have peroxide values less than 10mEq/kg. The low values of PV are indicative of low levels of oxidative rancidity of the oils and also suggest strong presence or high levels of antioxidant.
Mean peroxide value (PV) for almond and frytol were 4.073meq/kg and 6.327meq/kg respectively. The almond oil

was observed to have a significantly (*P<0.05*) lower value than the frytol oil due to the presence of natural antioxidant. Although peroxides are possibly not directly responsible for the taste and odour of rancid fats, their concentration as represented by the PV is often useful in assessing the extent to which the rancidity has advanced. A rancid taste often begins to be noticeable when the PV is above 20 meq/kg (Adelaja, 2006). The peroxide values are low and point to the fact that the oils may not be easily susceptible to deterioration.

Since, peroxide value correlates with the extent to which oxidative rancidity has taken place in oils, and thus a measure of the shelf life of oils, the almond oil is not rancid but good for consumption when fresh and considered stable (Ajayi and Oderinde, 2002).

Free fatty acids were probably formed by the hydrolytic activity of lipolytic enzymes during the preparation of seeds for oil production. Free fatty acid values of almond and frytol oils were 0.387% and 0.227% (as oleic acid) respectively. The significantly (*P<0.05*) high values of the free fatty acids in almond oil is probably due to the generation of more free fatty acids and hydrolysis during extraction as high temperature increases FFA values (Nagre *et al.*, 2011). The significantly (*p<0.05*) lower free fatty acid content of the frytol oil may result from the removal of inherent free non- fatty acid during refining, degumming and deodorization. Free fatty acid is very important in determining the use of oil for industrial or edibility purposes. The value obtained is within the allowable limit for edible oils (0-3) (Olatidoye et al, 2010). The oil could therefore be used as edible oil.

The results of the physical properties of the two studied oils (Almond and frytol) are presented in Table 2. At room temperature (28±3^0**C**), all the oils were liquids. Colours of the oils were golden yellow. The analyses revealed marked variations in the specific gravities, refractive indices, moisture content and impurities. The almond oil had a higher mean specific gravity of 0.923 whilst that of frytol was 0.815. The mean refractive indices obtained for almond and frytol oil were 1.465 and 1.454 respectively at the temperature of 25°C whereas mean moisture content (MC) and impurity (IMP) for almond and frytol oils were 0.55% and 0.19%, 0.133% and 0.096% respectively.

Table 2: Physical qualities of almond and frytol oils

Oil name	**Col.**	**State (28 ±3 ^{0}C)**	**S.G**	**MC (%)**	**IMP (%)**	**RI (25^{0}C)**
Almond	Golden	Liquid	0.923±0.06	0.550±0.06	0.133±0.006	1.465±0.00
Frytol	Golden	Liquid	0.815±0.00	0.191±0.00	0.096±0.001	1.454±0.00
Std.				0.05	0.20	

SG = Specific gravity, col = colour, MC= Moisture content, IMP= Impurity, RI= Refractive index, Std = Standard value

There is a significant (p<0.05) difference between parameters of almond and the frytol oil values at 95% confident limit.

Specific gravity is the heaviness of a substance compared to that of water, and it is expressed without units. The specific gravity obtained for all oil samples are less than 1.0 when measured at 30°C (Pearson, 1976). Almond oil was found to have a higher mean specific gravity of 0.923 whiles that of frytol was 0.815. These values are less than that reported for racemosa seed oil (4.947) by Amoo and Moza (1999) but the values of almond oil compared well with that reported for cotton seed (0.9202), coconut oil and sunflower seed (Pearson, 1976). By this value the oil is less dense than water.

There is a significant (*p< 0.05)* difference between specific gravity of almond oil and frytol oil. This may be due to the presence of higher levels of high molecular weight non- fatty resin acid in the almond oil than in the frytol oil. The frytol oil undergoes refining process to remove the acid (Artherton and Meara, 1939).

The refractive index and the iodine value are important characteristics which determine the degree of saturation or unsaturation of fat and oils. The mean refractive indices of 1.465 and 1.454 were obtained for almond and frytol oil

respectively at the temperature of 25 °C. This value for almond gives indication that the oil is less thick when compared with most drying oils whose refractive indices were between 1.475 and 1.485 (Duel, 1951).

The significantly ($P< 0.05$) low refractive index of the frytol compared to almond oil could be attributed to the nature of the fatty acids present since refractive index decreases with the molecular weight of the fatty acids. It can also be related to its lower iodine value since refractive index decreases with unsaturation (Cock, 1966).

Lower moisture content of oil indicates a better shelf life stability and hence the quality of an oil. Moisture contents of oil generally depend upon the duration of the drying process. Mean moisture content (MC) for almond and frytol oils were 0.55% and 0.19% respectively. There is significant ($p< 0.05$) difference between moisture level of almond oil and frytol oil. Low level of moisture content for frytol oil may be due to refining and deodorization processes used in its production.

Results of the shelf life of the oils analyzed (Almond and frytol) presented in Table 3 revealed variations in the free fatty acid and peroxide values. Rancidity (Kreis test) for the samples stored in the dark and day light (room) were negative throughout the period of study except day 56 and 63 that were positive for almond oil stored under room temperature.

Almond and frytol oils exposed to daylight (room) for one month at ambient temperature, FFA values rose from 0.387% to 0.465% and 0.227% to 0.220% respectively and the values rose to 0.585% and 0.490% respectively after two months.

FFA values for almond oil stored in the dark increased from 0.385% to 0.415% in the first month and rose to 0.485% in the second month. Similarly, the FFA value for frytol increased from 0.220% to 0.235% in the first month and recorded 0.260% in the second month. FFA values between almond oil stored in day light and in the dark for day7 and day14 have numerical differences in terms of their mean values but showed no significant ($p>0.05$) difference. However, FFA value of the almond oil stored in the day light was significantly ($p<0.05$) higher than that of the frytol. This may be due to the presence of an active lipase in the almond nut which upon milling quickly begins to hydrolyse triglycerides into free fatty acids, diglycerides and monoglyceride, and the lipase eventually decomposed all the triglycerides present over a period of several weeks. Also there was a significant ($p<0.05$) difference in FFA values between the oils stored in the dark. The hydrolytic changes though not predominant, indicated that the formation of free fatty acids increased with increasing time of storage.

The initial PV was seen to be higher in the almond oil compared with the frytol oil. This showed the relative oxygen uptake by the two oils under study. At the beginning of the experiment a peroxide value (PV) for almond oils exposed to day light (room) was

Table 3: Storage stability of almond and frytol oils stored under different storage conditions.
NB. Values are means of duplicate determinations with their standard deviation, OA= Oleic acid.
A -represent almond oil, B- represent frytol oil. There is a significant ($p<0.05$) difference between parameters of almond and the frytol oil values at 95% confidence limit. Values carrying the same super script are not significantly ($p>0.05$) different at confidence limit of 95%.

Oil	Storage period (Days)	Quality Parameters					
		Day light			Dark		
		FFA (% OA)	PV(meq/Kg)	Kreis	FFA (% OA)	PV(meq/Kg)	Kreis
A	0(fresh)	0.390±0.00	4.073±0.000	-	0.390±0.000	4.073±0.000	-
	7	0.395±0.007*	5.415±0.007	-	0.390±0.000*	4.955±0.007	-
	14	0.425±0.007*	7.825±0.007	-	0.410±0.014*	5.860±0.509	-
	21	0.440±0.000	9.250±0.099	-	0.415±0.007	5.865±0.007	-
	28	0.465±0.007	11.275±0.03	-	0.415±0.007	6.756±0.001	-
	35	0.480±0.000	14.450±0.01	-	0.430±0.000	8.665±0.707	-
	42	0.525±0.007	17.520±0.01	-	0.435±0.007	9.616±0.001	-
	49	0.540±0.000	20.335±0.02	-	0.455±0.007	11.633±0.050	-
	56	0.555±0.007	22.235±0.00	+	0.465±0.007	13.210±0.000	-
	63	0.585±0.007	25.670±0.00	+	0.485±0.007	15.115±0.000	-
B	0(fresh)	0.220±0.000	6.320±0.000	-	0.220±0.000	6.320±0.000	-
	7	0.225±0.007	7.155±0.078	-	0.215±0.007	6.825±0.007	-
	14	0.235±0.007	8.425±0.021	-	0.225±0.007	7.950±0.008	-
	21	0.245±0.007	10.050±0.07	-	0.235±0.007	8.607±0.074	-
	28	0.315±0.021	11.640±0.01	-	0.235±0.007	9.865±0.071	-
	35	0.425±0.021	12.890±0.07	-	0.240±0.000	10.305±0.000	-
	42	0.460±0.014	14.425±0.00	-	0.245±0.007	10.305±0.000	-
	49	0.465±0.007	15.140±0.01	-	0.250±0.000	11.607±0.023	-
	56	0.475±0.007	17.030±0.02	-	0.255±0.007	12.175±0.000	-
	63	0.490±0.000	19.150±0.05	-	0.260±0.000	12.950±0.000	-

4.073meq/kg and after one month the value rose to 9.250 meq/Kg and further to 25.670meq/Kg after two months. The PV for frytol oils under the same condition as above rose from 6.327meq/kg to 11.640 meq /kg and then recorded 19.150 meq/kg after two months. There is a significantly ($p<0.05$) higher difference between the almond and the frytol oil. The higher almond value may be due to the presence of sunlight and temperature as increase in temperature increases the rate of oxidation. Also the significantly ($p< 0.05$) high difference in PV of the almond oil in comparison with the frytol oil may be due to high level of unsaturation in the almond oil.

PV for almond and frytol oils stored in darkness (Table 3) did not show such a sharp increase after the first and second month of storage. During the first month, PV for almond oil increased from 4.073 meq/kg to 6.756 meq/kg and increased further to 15.115 meq/kg in the next months. That of frytol oil increased from 6.32meq/kg to 9.865meq/kg and in the next months recorded 12.950meq/kg. Though there was a progressive increment in PV for the oils in the dark up to two months of storage, the values did not exceed the limits specified by codex for most vegetable oils.

The significantly ($p<0.05$) higher difference between the oils stored in day light (room) and in the dark may be due to the effect of sunlight and temperature differences as increase in temperature increases the rate of oxidation. Also, high level of unsaturation in the almond oil could account for this significant difference.

The rancidity (Kreis) test carried out on the samples for both storage conditions for the first month was negative

however, those exposed to light (room) on day fifty six (56) and sixty three (63) were positive.
The mean mesophilic count for almond oil was $4x10^3$ cfu/ml and that of frytol oil was $4.8x10^3$ cfu/ml. For fungi (yeast and mould), the mean plate count on almond and frytol oils were $1.4x10^3$ cfu/ml and $1.3x10^3$ cfu/ml respectively however, detections for *Salmonella* in both samples were negative (Table 4). The mean values of frytol were numerically higher than almond oil but there was no significant difference between them. They all fell within the acceptable range by Codex.

Table 4: Mean microbial populations and detections of almond and frytol oils

	Microbial population (cfu/ml)		Detections
Name of sample	Total mesophilic count	Yeast and Moulds	*Salmonella*
Almond oil	$4x10^3$ ±282.843	$1.4 x10^3$ ±141.421	-
Frytol oil	$4.8 x10^3$ ±282.843	$1.3 x10^3$ ±141.421	-
Std	10^5cfu/ml		

Values are means of duplicate determinations with their standard deviations, Std- Standard
- represents no detection.

5. Conclusion

The physico-chemical properties of almond nut have been studied for their domestic and commercial applications. The colour of the oil was yellow and it was liquid at room temperature. The nut have been found to have good oil yield of over 52.11% which is comparable to the oil yield of some commercial seed oils such as groundnut, coconut and palm oil. High saponification value (168.27mgKOH/Kg) guarantees the use of the oils in cosmetics industry. The acid value of the almond is lower than the maximum permissible acid level of 4mgKOH/g fat or oil required for edible virgin fats and oils and therefore it is suitable for direct consumption. The result obtained shows that the oil is good for consumption when freshly produced, since the physico- chemical characteristics are within the stipulated limits recommended by Codex. However the oil recorded high iodine values suggesting almond oil is highly unsaturated and may be susceptible to rancidity.

Prior to the study, the physicochemical characteristics of the oil largely conformed to codex standards. Depending on the mode of storage, the physicochemical properties changed significantly with storage time. The highest changing property was that of peroxide in oils exposed to light. Oils kept in tightly sealed containers and stored in the dark (absence of light) exhibited little change. Therefore, in order for edible oils to keep their quality characteristics, they should be stored in air tight, transparent containers. It is also recommended that synthetic antioxidants be used during production in order to enhance storage stability of the oil.

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