Research Journal of Food and Nutrition
Volume 2, Issue 2, 2018, PP 32-40

Comparative Assessment of the Physicochemical Properties and Fatty Acid Profile OF Fluted Pumpkin Seed Oil with Some Commercial Vegetable Oils in Rivers State, Nigeria

Chibor Bariwere Samue[1*], Kiin-Kabari David Barine, Eke-Ejiofor Joy

Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria

***Corresponding Author:** Chibor Bariwere Samue, Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria*

ABSTRACT

The objective of this work was to assess the physicochemical characteristics and fatty acid profile of fluted pumpkin (Telfairia occidentalis) seed oil and compare with some commercial seed oils (refined palm kernel oil, Grand soya oil and groundnut oil) sold in Rivers State, Nigeria. Edible oils were extracted from the seed of fluted pumpkin. The oils were analysed for chemical composition, physical properties, and fatty acid profile.Percentage moisture impurities and volatile matters (MIV) ranged from 0.065% - 0.095%, with fluted pumpkin seed oil given the least value of 0.065%.There was no significant difference (P<0.05) between the specific gravity of fluted pumpkin seed oil and those of the commercial vegetable oils (at 30^0C).The cloud and slip melting points of fluted pumpkin seed oil (FPSO) and Grand soya oil were significantly lower than those of the unbranded commercial vegetable oils. The smoke and flash points of FPSO were 244.50^0C and 299.00^0C, respectively. All the oil samples had colour within the standard acceptable range for refined vegetable oil. The free fatty acids, acid value and peroxide value of FPSO were 0.040%, 0.080% and 1.070mEq/kg, respectively, these values were significantly (P<0.05) lower than those of groundnut oil and refined palm kernel oil (RPKO), but not significantly different from Grand soya oil.Iodine values for FPSO, Grand soya oil, groundnut oil and RPKO were respectively 119.85g/100g, 128.10g/100g, 90.25g/100g and 20.05g/100g. The total unsaturated fatty acids in FPSO was 80.1%, with 62.4% linoleic acid (omega-6). Grand soya oil, groundnut oil and RPKO gave total unsaturated fatty acid values of 86%, 83.5% and 18.5%, respectively. Fluted pumpkin seed oil and Grand soya oil were richer in polyunsaturated fatty acids than groundnut and palm kernel oils. The physicochemical properties of fluted pumpkin seed oil meet the recommended FAO standard, compares favourably with the branded Grand soya oil, and performs better than unbranded groundnut and palm kernel oils.

Keywords: *Physicochemical, Fatty Acid Profile, Fluted Pumpkin, Commercial Vegetable Oils.*

INTRODUCTION

The need for adequate supply of calories and other essential nutrients is a major concern in most developing countries. Fats and oil are noted for their high energy potentials; they are recognized as essential nutrients in human diets. They provide essential fatty acids which are the building blocks for the hormones needed to regulate body systems. Fats and oil are concentrated sources of energy, and a carrier for vitamins A, D, E, and K (Stevenson *et al*., 2007). They provide mouth feel, texture, and impart flavour, thus enhancing the quality of food we eat, and also contributes to the feeling of satiety after eating (Stevenson *et al*., 2007). Fats and oils find functional application in food processing and food preparation, as tenderizing agents, enhancing dough aeration and shortening functions (CIA, 1996). They carry flavors, and colour. Lipids (fats and oil) also provide a heating medium for food preparation (Katragadda *et al*., 2010). This all-important nutrient is sourced in many foods, such as fish, meats, dairy products, seeds and nuts. Commercially available vegetable oils in Nigeria are sourced predominately from palm fruits/kernel, groundnuts, and soyabeans.Insufficient vegetable oils in Nigeria markets and its corresponding high cost now call for greater attention to be given to sourcing vegetable oils from other underutilized oil seeds.

Fluted pumpkin (*Telfairia occidentalis* Hook F) belongs to the family Cucurbitaceae. It is a green vegetable that is grown in West Africa basically for the consumption of its leafy vegetable and its seeds, which are also edible.

(Nkang *et al*., 2003). The crop is cultivated mostly in the southern part of Nigeria across lowland humid tropics and it is also a drought tolerant – perennial crop. *Telfairia* is cultivated primarily for its leaf, which is used in West African countries predominantly for preparing assorted diets. (Agatemor,2001; Ajibade, *et al*., 2006). Its leaves and young shoots are used for soup (Aletor*et al.,* 2002).Due to its high oil yield, 52 – 54% (Giami *et al*.,1999; Chibor *et al*., 2017) fluted pumpkin seeds are potential sources of industrial and domestic oil, with high nutritional value. (Okoli and Nyanayo, 1988; Horsef all and Spiff, 2005; Akang *et al.*, 2010). Its Iodine value is high (119.65g/100g - 123.83g/100g) as reported by Chibor *et al*. (2017) and Nwabanne (2012), this is an indication that it contains more poly-unsaturated fatty acids (Agatemor, 2006). The seed contains oil which is used for cooking and production of margarine (Horsf all, and Spiff, 2005; Agatemor, 2006; Akang *et al.*, 2010). Pumpkin seed oil provides many health benefits when consumed. It has been reported to contain 64.41% linoleic acid (Muibat *et al*., 2011). Linoleic acid is an essential fatty acid that helps maintain healthy blood vessels, nerves and tissues (Nwabanne, 2012). Pumpkin seed oil is known to alleviate and avert bladder and prostrate problems, it is often prescribed to men over fifty years with prostrate problems (Akang *et al.*, 2010; Odoemena, and Onyeneka, 1998; Obo *et al*., 2006). It has also been shown to poses some essential components such as vitamin A (0.89µg/g) as reported by Agatemor (2006). This had been shown to suppress peroxidation of lipid, hence improving testicular function (Bensonssan *et al*., 1998; Leat *et al*., 1983). In spite of its numerous nutritional, physicochemical and economic benefits, fluted pumpkin seed oil is yet to be used commercially for domestic and industrial applications in Nigeria, thus, the objective of this work was to assess the physicochemical characteristics and fatty acid profile of fluted pumpkin (*Telfairiaoccidentalis*) seed oil and compare with some commercial seed oils sold in Rivers State, Nigeria.

MATERIALS AND METHODS

Freshly harvested fluted pumpkin fruits were procured from Bori market in Rivers State, Nigeria. Thefluted pumpkin seeds were dehulled and washed, the cotyledons oven dried at 60^{o}C for 24h (Giami *et al*.,1999) in a hot air oven (model QUB 305010G, Gallenkamp, UK), ground using a laboratory mill (model MXAC2105, Panasonic, Japan). Oil was extracted using the bulk extraction process, with n-Hexane as described by AOAC (2012).

Oil Refining

The extracted fluted pumpkin seed oils were refined using the procedure described by O'Brien (2004) with slight modifications. The crude oil was treated with 8% NaOH $_{(aq)}$ at 65^{0}C for 10min with continuous stirring, using a laboratory stirrer (model JKL 2145, REMI Motors, India). The treated oil was then washed with warm distilled water and the aqueous phase was separated off using a separatory funnel. The washing process was repeated until the aqueous phase became neutral to phenolphthalein indicator. The separated oil was dried at 100^{0}C before bleaching with fuller's earth. To 100ml of the dried oil sample was added 3g of fuller's earth in a 250ml conical flask. The entire content was stirred continuously for 20min with a magnetic stirrer while heating at 80^{0}C. It was filtered at 50^{o}C using Whatman no 4 filter paper, to obtain refined fluted pumpkin seed oil.

Some commercial seed oils used in Rivers State, Nigeria were purchased from Rumuokoro market in Port Harcourt and used for comparative analysis. The commercial vegetable oils were: refined palm kernel oil (RPKO unbranded), groundnut oil (kuli-kuli oil unbranded), and Grand soya oil (branded soya bean oil).

Physicochemical Properties

Physicochemical properties including; Moisture impurities and volatile matters, Refractive index, specific gravity, cloud point, melting point, smoke point, flash point, viscosity, free fatty acid, peroxide value, iodine value, saponification value, unsaponifiable matter, and acid value were determined by the method of AOAC (2012). Viscosity measurement (in centistokes, cSt) was performed using an Ubbelohde glass capillary viscometer (size 2. A149, Cannon instrument, PA, USA). Refractive index was performed using the Abbe Refractometer model 2WAJ (Wincom, China). Colour was determined using procedure Cc 13e 09-94 of AOCS (1997). The oil was properly melted and filtered through What man No. 4 filter paper, to remove any impurity and trace of moisture. The glass cell (0.5inch cuvette) was cleaned with carbon tetrachloride (CCl_4), and filled with the oil sample, then placed in

position in the Lovibond Tintometer; (model 5064E, Amesbury, England). The colour was matched with sliding red, yellow and blue colours, and expressed as the sum total of the yellow, red and blue slides used to match the colour of oil in the glass cuvette, match was recorded as Y=yellow and R= red.

Ester value (EV) was evaluated by calculation, as described by (Aremu *et al*., 2015). EV=SV-AV (Saponification Value-Acid value).

Fatty Acid Profile

The individual fatty acids in the oils were determine using the AOAC (2012) methods as described by Chibor *et al.*, (2017). Fatty acid methyl esters (FAME) were prepared from the extracted oils. In 50 ml round bottom flasks, 50 mg of each sample was kept in separate flasks and 3 ml of sodium methylate solution (0.5mol/l of methanolic solution of NaOH) was added. The reaction medium was refluxed for 10 minutes; 3 ml of acetyl chloride was added; mixture was refluxed again for 10 minutes and then cooled to ambient temperature; 8 ml hexane and 10 ml of distilled water was added and allowed to stand for 5 minutes to establish a two phase solution. The upper organic phase was recovered into a vial for GC analysis, using Agilent 7890A, coupled with flame-ionization detector (FID).

Statistical Analysis

All the analyses were carried out in duplicate. Data obtained were subjected to Analysis of variance (ANOVA), differences between means were evaluated using Tukey's multiple comparison test, and significance accepted at $P \leq 0.05$ level. The statistical package in Minitab 16 computer program was used.

Results and Discussion

Physical Properties of Fluted Pumpkin Seed Oil and the Commercial Seed Oils

Result for the physical properties of the vegetable oil samples are shown in Table 1. Percentage moisture impurities and volatile matters (MIV) ranged from 0.065% - 0.095%, with fluted pumpkin seed oil given the least value of 0.065%. Percentage MIV of all the oils samples wereless than 0.2%, which is the maximum allowable MIV for refined, bleached and deodorized vegetable oils (NIS, 1992; CODEX, 1999).

Fluted pumpkin seed oil (FPSO) and Grand soya oil (GSO) gave refractive index (RI) of 1.467, this value compares with 1.463 reported by Bwade*et al* (2013) and 1.462 reported by Eddy *et al* (2011), for fluted pumpkin seed oil. The RI of groundnut oil (GNO) was significantly ($P<0.05$) higher at 1.471, while refined palm kernel oil (RPKO) recorded the least RI of 1.423.Refractive index of fat had been reported to increase with increase in chain length of the fat, and also with the number of unsaturated bonds present in the fat (Nielson, 1994). Refractive Index also depend on the degree of conjugation as well as the degree of unsaturation of the oil (Shahidi, 2005). Higher value of RI recorded by FPSO, GSO and GNOis an indication that the oils contain more unsaturated fatty acids than RPKO.

The difference between the specific gravity of fluted pumpkin seed oil and those of the commercial vegetable oils (at 30^0C) were not significant ($P>0.05$).

As shown in Table 1, fluted pumpkin seed oil clouds at 1.25^0C, which is significantly lower ($P<0.05$) than groundnut and palm kernel oil. Grand soya oil gave an extraordinary low cloud point of 0^0C, which agrees with report of earlier researchers (Angaye and Maduelosi, 2015).

The slip melting point of the oils ranged from 0.55^0C – 25.35^0C, with Grand soya oil given the least SMP of 0.55^0C. SMP of FPSO was significantly ($P<0.05$) lower than those of groundnut and palm kernel oils, indicating that FPSO will remain liquid at temperature lower than ambient.

Fluted pumpkin seed oil (FPSO) and Grand soya oil (GSO) gave smoke points of 244.50^0C and 246.50^0C, respectively, these values were significantly higher than those of groundnut (kuli-kuli) oil and refined palm kernel oil (RPKO). High smoke point of FPSO showed that the oil is suitable for a wide range of cooking operations, as supported by earlier researchers (Chibor *et al.*, 2017). The smoke point serves as an indicator to the temperature limit which a particular cooking oil can be used, it increases when the degree and efficiency of refinement increases (Bockish, 1998).

Fluted pumpkin seed oil flashed at 299^0C, much higher than GNO and RPKO, making it suitable for high temperature deep frying.

With kinematic viscosity value of 24.05cSt (@40^0C), FPSO showed less resistance to flow

than RPKO, but significantly (P<0.05) more than GSO and GNO.

Result for Lovibond colour intensity, gave FPSO 1.8R, 20.0Y and GNO relatively high at 2.8R, 20.2Y. However, all the seed oils studied were within the standard colour range of 1.0 – 3.0 red for refined vegetable oil (NIS:289, 1992).

Table 1.*Physical Properties of Fluted Pumpkin Seed Oil and the Commercial Seed Oils*

PARAMETERS	OIL SAMPLES			
	FPSO	GSO	GNO	RPKO
MIV (%)	0.065^{b}±0.007	0.070^{b}±0.000	0.075^{ab}±0.007	0.095^{a}±0.007
RI	1.467^{b}±0.001	1.467^{b}±0.000	1.471^{a} ±0.001	1.423^{c}±0.001
SG (@30^{0}C)	0.904^{a}±0.001	0.903^{a} ±0.000	0.904^{a}±0.001	0.901^{a}±0.001
CDP (^{0}C)	1.25^{c} ±0.354	0.000^{d} ±0.000	4.55^{a} ±0.071	2.70^{b}±0.141
SMP (^{0}C)	17.23^{c} ±0.354	0.55^{d} ±0.071	20.10^{b} ±0.140	25.35^{a}±0.071
SMOKE P. (^{0}C)	244.50^{a} ±0.707	246.50^{a} ±0.707	129.50^{c} ±0.707	191.50^{b}±0.701
FP (^{0}C)	299.00^{b} ±1.414	309.50^{a} ±0.707	199.50^{d} ±0.707	224.00^{c}±0.000
VS (cSt. @40^{0}C)	24.05^{b} ±0.071	18.15^{d} ±0.212	20.20^{c} ±0.283	28.93^{a}±0.318
L. COL.	1.8R, 20.0Y	1.5R, 20.0Y	2.8R, 20.2Y	2.5R, 20.2Y

Values are means ± standard deviation of duplicate samples.

Mean values bearing different superscripts in the same row differ significantly (p<0.05).

***Key**: MIV= moisture impurities and volatile matters, RI= refractive index, SG= specific gravity, CDP= cloud point, SMP= slip melting point, SMOKE P.= smoke point, FP= flash point, VS= viscosity, L. COL= Lovibond colour intensity.*

***FPSO**= fluted pumpkinseed oil, **GSO**= Grand pure soya oil (commercial), **GNO**= ground nut oil (commercial kuli-kuli oil), **RPKO**= refined palm kernel oil (commercial).*

Chemical Properties of Fluted Pumpkin Seed Oil and the Commercial Seed Oils.

Result for chemical properties of the vegetable oil samples are shown in Table 2. The percentage free fatty acid (FFA) of fluted pumpkin seed oil (FPSO) was 0.040%, much lower than the commercial vegetable oils studied, though not significantly different (P>0.05) from GSO. It was also lower than the maximum allowable value of 0.3% for refined vegetable oil (NIS, 1992; CODEX, 1999). Free fatty acid values for the unbranded oils (GNO and RPKO) were high. Their values ranged from 0.682- 1.048% which is higher than the stipulated 0.3max by CODEX (1999). This is an indication that the extent of hydrolytic rancidity in these oils is appreciable (Angaye and Maduelosi, 2015).

As shown in Table 2, Peroxide value (PV) of the oils ranged from 1.020mEq/kg – 9.675mEq/kg, with least values of 1.020mEq/kgand 1.070mEq/kgfor GSO and FPSO, respectively.The PV of all the oil samples were lower than 10mEq/kg, which is the maximum allowable value for PV (CODEX, 1999). Peroxide value (PV) gives an indication of the degree of fat oxidized (Ononogbu, 2002; Okashi*et al*., 2013).

Fluted pumpkin seed oil recorded iodine value of 119.85g/100g. This value was higher than 90.25g/100g and 20.05g/100g given by groundnut oil and refined palm kernel oil, respectively. Iodine value is a simple chemical constant used to measure the degree of unsaturation or the average number of double bonds in an oil sample. It is the number of grams of iodine that could be used to halogenate 100 g of oil (Ononogbu, 2002;Shahidi, 2005).

The refined fluted pumpkin seed oil gave saponification value (SV) of 198.50mgKOH/g which was significantly (P<0.05) lower than 248.80mgKOH/g and 250.35mgKOH/g shown by GNO and RPKO, respectively. Oil with high saponification value is suitable for soaps and shampoo, pharmaceutical, and food processing (Aremu*et al.*, 2015), low saponification value is also suitable for food processing (Chibor *et al.*, 2017).Saponification value is a measure of the alkali-groups in fats and oil and is defined as the mg KOH needed to saponify 1g of oil (Shahidi, 2005). It is a measure of all the saponifiable fatty acids (including the esters) present in oil (Aremu *et al.*, 2015).

From Table 2, the percentage unsaponifiable matter (USM) content of FPSO, GSO and RPKO were not significantly different (P<0.05) and also within standard range of 0.1 – 0.15%

USM for refined vegetable oil (NIS, 1992). High USM content of groundnut (kuli-kuli) oil is probably due to it virgin nature. Earlier researchers reported that considerably high presence of USM is an indication that the oil is rich in desirable bioactive components such as; antimicrobial, antioxidants, and anti-inflammatory substances, including the fat soluble vitamins (Nahm, 2011).

The acid value (AV) of fluted pumpkin seed oil was 0.08mgKOH/g and significantly ($P<0.05$) lower than the commercial vegetable oils, except GSO. It was also lower than 0.6mgKOH/g which is the maximum allowable standard for refined vegetable oil (NIS, 1992; CODEX, 1999).A low AV means that an oil sample contains less free acids thus reducing its exposure to rancidity (Asuquo *et al*., 2012; Anderson-Foster *et al*., 2012). However, acid value as high as 4.0mgKOH/g (max) are permitted for cold press and virgin oil (CODEX, 1999).

The ester value (EV) of all the oil samples was appreciably high. EV is an indication of the saponifiable fatty acids excluding the free acids of the fat (Aremu *et al*., 2015). High ester value is an indication that the oils have good flavour suitable for culinary purposes.

Table 2: *Chemical Properties of Fluted Pumpkin Seed Oil and the Commercial Seed Oils*

PARAMETERS	OIL SAMPLES			
	FPSO	GSO	GNO	RPKO
FFA (%)	0.040^{c}±0.000	0.055^{c} ±0.001	1.048^{a} ±0.074	0.682^{b} ±0.042
PV (mEq/kg)	1.070^{c} ±0.014	1.020^{c} ±0.028	9.675^{a} ±0.248	5.105^{b}±0.149
IV (g/100g)	119.85^{b} ±0.071	128.10^{a} ±0.141	90.25^{c} ±0.354	20.05^{d}±0.247
SV (mgKOH/g)	198.50^{c} ±0.141	198.55^{c} ±0.354	248.80^{b} ±0.424	250.35^{a}±0.071
USM (%)	0.135^{b} ±0.035	0.095^{c} ±0.007	0.350^{a} ±0.071	0.100^{b}±0.000
AV (mgKOH/g)	0.080^{c} ±0.000	0.109^{c} ±0.013	2.085^{a} ±0.149	1.358^{b}±0.080
EV (mgKOH/g)	198.57^{c} ±0.354	198.44^{c} ±0.340	246.72^{b} ±0.276	248.99^{a}±0.000

Values are means ± standard deviation of duplicate samples.

Mean values bearing different superscripts in the same row differ significantly ($p<0.05$).

***Key**: FFA= free fatty acid, PV= Peroxide value, IV= Iodine Value, SV= Saponification value, USM= Unsaponifiable matter, AV= acid value, EV= ester value,*

***FPSO**= fluted pumpkinseed oil, **GSO**= Grand pure soya oil (commercial), **GNO**= ground nut oil (commercial kuli-kuli oil), **RPKO**= refined palm kernel oil (commercial).*

Table 3.*Fatty Acid Profiles of Fluted Pumpkin Seed Oil (FPSO), Grand Soya oil (GSO), Groundnut Oil (GNO) and Refined Palm Kernel Oil (RPKO).*

FATTY ACIDS	OIL SAMPLES				
(%)	FPSO	GSO	GNO	RPKO	
Caprilic (C8:0)	-	-	-	3.0	
Capric (C10:0)	-	-	-	3.0	
Lauric (C12:0)	-	-	-	50.0	
Myristic (C14:0)	0.1	0.5		16.0	
Palmitic (C16:0)	17.5	7.0	6.0	8.0	
Palmitoleic (C16:1)	1.2	-	-	-	
Stearic (C18:0)	0.8	4.5	5.5	1.5	
Oleic (C18:1)	14.1	24.0	59.5	18.0	
Linoleic (C18:2)	62.4	55.0	24.0	0.5	
Linolenic (C18:3)	-	8.0	-	-	
Arachidic (C20:0)	-	1.0	3.0	-	
Eicosenoic (C20:1)	2	-	-	-	
Eicosatrienoic (C20:3)	0.3	-	-	-	
Behenic (C22:0)	-	0.5	1.0	-	
Lignoceric (C24:0)	1.5	0.5	1.0	-	

Fatty Acid Profiles of Fluted Pumpkin Seed Oil (FPSO), Grand Soya oil (GSO), Groundnut Oil (GNO) and Refined Palm Kernel Oil (RPKO).

From Table 3,the total saturated fatty acid in FPSO, GSO, GNO and RPKO were respectively 19.9%, 14%, 16.5% and 81.5%. RPKO with high content of saturated fatty acids still present

low melting point (25.35^{0}C), this is probably due to the presence and high content of low molecular weight fatty acids, such as, lauric, capric and caprylic acids. Low molecular weight fatty acids are said to be associated with coronary heart disease and atherosclerosis (Juttelstad, 2004; Ascherio, 2006). The total unsaturated fatty acids in FPSO was 80.1%, with 62.4% linoleic acid (omega-6). High content of linoleic acid (polyunsaturated fatty acid) in fluted pumpkin seed oil makes it nutritionally desirable and heart friendly, it is an essential fatty acid that help maintain healthy blood vessels, nerves and tissues (Nwabanne, 2012). Grand soya oil contained 86% total unsaturated fatty acids, with 55% linoleic (omega-6) acid and 8% linolenic (0mega-3) acid.Groundnut oil (kuli-kuli) contained 83% total unsaturated fatty acid, with 59.5% oleic acid. Fluted pumpkin seed oil and Grand soya oil are richer in polyunsaturated fatty acids than groundnut and palm kernel oils.

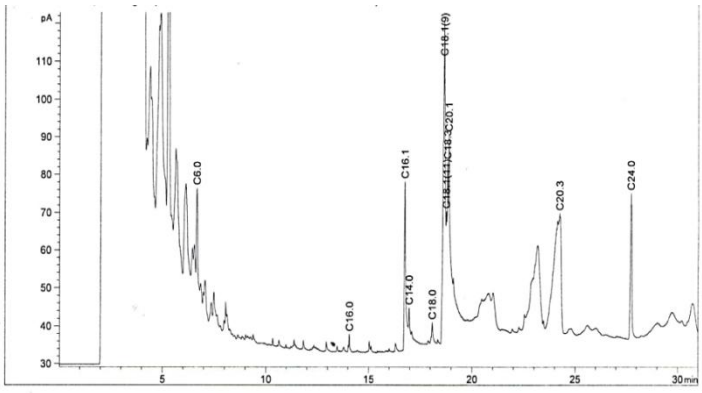

Figure1. Fatty acid GC Chromatogram of Fluted pumpkin seed oil (FPSO)

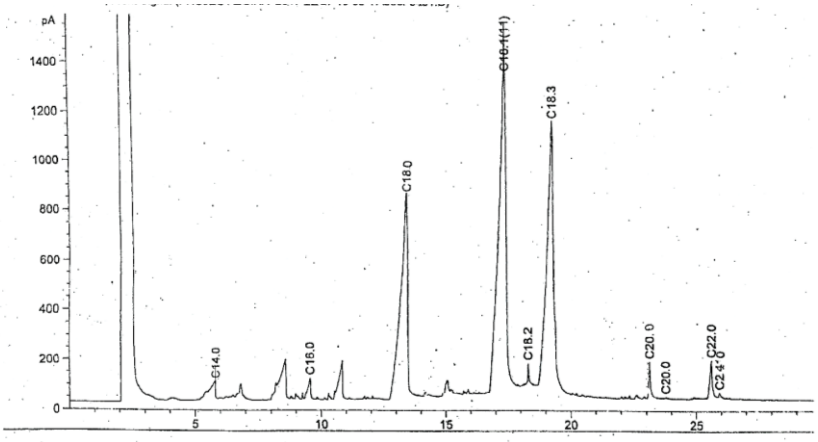

Figure 2. Fatty acid GC Chromatogram of Grand Soya Oil (GSO)

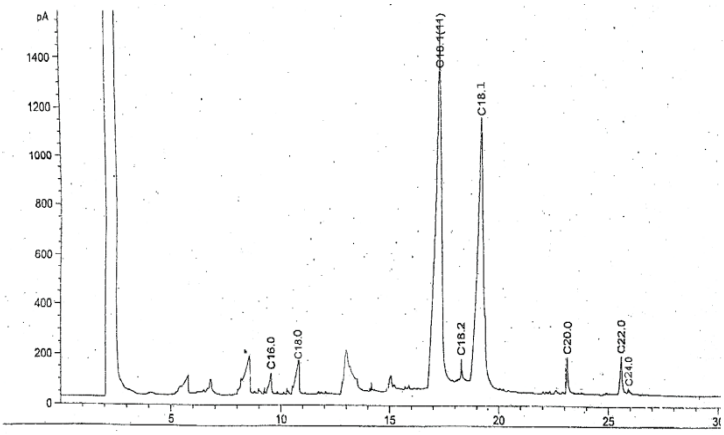

Figure 3. Fatty acid GC Chromatogram of Groundnut Oil (GNO)

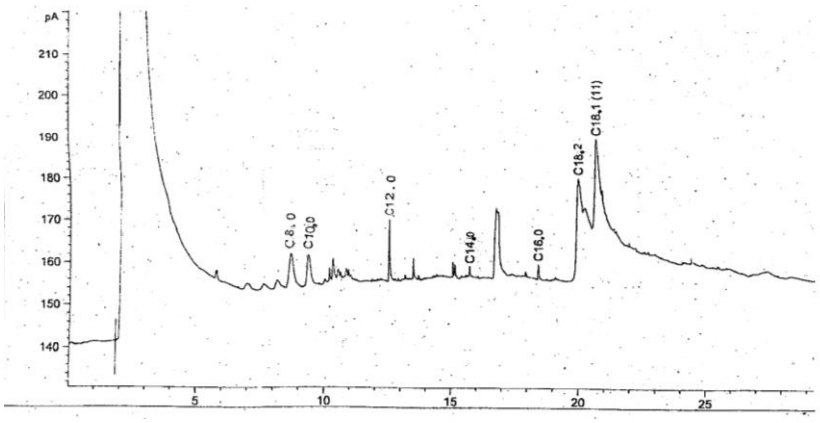

Figure 4. Fatty acid GC Chromatogram of Refined Palm Kernel Oil (RPKO)

CONCLUSION

From the study, fluted pumpkin seed oil showed low cloud and melting points, high smoke and flash points, these compared favourably with the branded Grand soya oil, and performed appreciably better than the unbranded commercial vegetable oils (RPKO and groundnut "kuli-kuli" oil). High content of polyunsaturated fatty acids in fluted pumpkin seed oil makes it a ready source of heart friendly essential fatty acids, thus, its use for domestic and wide scale culinary purposes should be encouraged. To minimize the incidence of oxidative breakdown due to high unsaturation, absolute caution is needed for packaging and storage of fluted pumpkin seed oil. However, changes in the physicochemical characteristics of fluted pumpkin seed oil as compared to other commercial vegetable oils during storage shall be investigated in the next study.

REFERENCES

[1] Agatemor, C. (2001). Studies of Selected Phytochemical Properties of Flutedpumpkin (TelferiaoccidentalisHookf.) Seed Oil and Tropical Almond (TerminalisCatappial) Seed Oil. Pakistan Journal of Nutrition,5, 306-330.

[2] Agatemor, C. (2006). Nutritional Composition of Fluted Pumpkin (Telfairiaoccidentalis Hook F) Seed. Analytical Chemistry. An Indian Journal. 3(1), 7-10

[3] Ajibade, S.R.,Balogun, M.O.,Afolabi, O.O. and Kupolati, M.D. (2006). Sex Differences in The Biochemical Contents of TelfairiaoccidentalisHook F. Journal of Food Agriculture and Environment,4, 155-156.

[4] Akang, E. N, Oremosu, A. A, Dosumu, O. O, Noronha, C. C, and Okanlawon, A.O. (2010). The Effect of Fluted Pumpkins (Telfairiaoccidetalis) Seed Oil (FPSO) on Testis and Semen Parameters. Agriculture and Biology Journal of North America, 1(4), 697-703.

[5] Aletor, 0.J., Oshodi, A.A. and Ipinmoroti, K. (2002), Chemical Composition of Leafy Vegetables and Properties of their Leaf Protein Concentrates. Food Chemicals. 78, 63-68.

[6] Aletor, 0.J., Oshodi, A.A. and Ipinmoroti, K. (2002), Chemical Composition of Leafy Vegetables and Properties of their Leaf Protein Concentrates. Food Chemicals. 78, 63-68.

[7] Anderson-Foster, E.N., Adebayo, A.S. and Justiz-Smith, N. (2012). Physico-Chemical Properties of Blighiasapida (Ackee) Oil Extract and Its Potential Application as Emulsion Base. African Journal of Pharmacology,6, 200-210.

[8] Angaye, S.S and Maduelosi, N.J. (2015). Comparative Study of the Physicochemical Properties of Some Refined Vegetable Oils Sold in Mile One Market and Some Departmental Stores in Port Harcourt, Rivers State, Nigeria. Food Science and Quality Management, 39. Retrieved from http://www.iiste.org/journals. 12 January 2018.

[9] AOAC. (2012). Official Methods of Analysis of the Association of Analytical Chemists. 19th Edition. Washington, DC, USA.

[10] AOCS. (1997). The Official Methods and Recommended Practices of American Oil Chemists' Society. Champaign Illinois: American Oil Chemists' Society Press.

[11] Aremu, M.O., Ibrahim, H., and Bamidele, T.O. (2015). Physicochemical Characteristics of the Oils Extracted from Some Nigerian Plant Foods. Chemical and Process Engineering Research. 32, 22-25.

[12] Ascherio, A. (2006). Trans fatty acids and blood lipids. Atheroscler. Suppl., 1: 25-27.

[13] Asuquo, J.E., Anusien, A.C.I., and Etim, E.E. (2012). Comparative Study of the Effect of Temperature On the Adsorption of Metallic Soaps of Shea Butter, Castor and Rubber Seed Oil or to Hematite. International Journal of Modern Chemistry,3, 39-50.

[14] Bensonssan, K., Moreles, C. and Hermol, L. (1998). Vitamin E Deficiency Causes Incomplete Spermatogenesis and Effects the Structural Differentiation of Epithelial Cells of the Epididymis in Rat. Journal of Andrology, 19(3), 266-288.

[15] Bockish, M. (1998). Fats and Oils Handbook, Champaign, IL: American Oil Chemists' Society Press.

[16] Bwade, K.E., Aliyu B. and Kwaji, A.M. (2013). Physicochemical Properties of Pumpkin Seed Oil Relevant to Biodiesel Production and Other Industrial Applications. International Journal of Engineering Business and Enterprise Application,4(1), 72-78.

[17] Chibor, B.S., Kiin-Kabari, D.B. and Ejiofor, J. (2017). Physicochemical Properties and Fatty Acid Profile of Shea Butter and Fluted Pumpkin Seed Oil, a Suitable Blend in Bakery Leat, W. M, Narthrop, C. A., Hamson, F. A.and Cox, R.W. (1983). Effect of Dietary Linoleic and Linolenic Acids On Testicular Development in The Rat. Quarterly Journal of Experimental Physiology, 68(2), 221-231.

[18] CODEX-STAN. (1999). CODEX Alimentairus Commission Standard for Named Vegetable Oils, FAO Corporate Document, CODEX STAN 210. Retrieved from https://www.fao.org/docrep/004/y2774e05. 5th July, 2017Culinary Institute of America (CIA). (2011). The Professional Chef. (9th Ed). New Jersey: John Wiley and Sons, Inc.

[19] Eddy, N.O., Ukpong, J.A. and Ebenso, E.E. (2011). Lipids Characterization and Industrial Potentials of Pumpkin Seeds (Telfairiaoccidentalis and Cashew Nuts (Anacardiumoccidentalis). European Journal of Chemistry, 8(4), 1986-1992.

[20] Fat Production. International Journal of Nutrition and Food Sciences. 6(3), 122-128.

[21] Giami, S. Y., Chibor, B. S., Edebiri, K. E. andAchinewhu,S. C. (1999). Changes in Nitrogenous and Other Chemical Constituents, Protein Fractions and In-Vitro Protein Digestibility of Germinated Fluted Pumpkin (Telfairiaoccidentalis Hook) Seed. Plant Foods for Human Nutrition,53, 333-342

[22] Gordon, M. D. (1993). Fats, fatty foods, In Ranken, M. D, and Kill, R. C (eds). Food Industries Manual 23rd edi. Blacke Academic and professional, London, pp. 179-186.

[23] Horsfall, M.J and Spiff, I. A. (2005). Equilibrium Sorption Study of Al_3^+, Co_3^{2-}, and Ag^+ in Aqueous Solution by Fluted Pumpkin (Telfairiaccidentalis Hook F) Waste Biomass. ActaChemica. Slovinica, 52, 174-1.

[24] Juttelstad A (2004) The marketing of trans fat-free foods. Food Technol 58: 20.

[25] Katragadda, H. R.., Fullana, A. S., Sidhu, S. andCarbonell-Barrachina, Á. A. (2010). Emissions of Volatile Aldehydes from Heated Cooking Oils. Food Chemistry,120,59-64.

[26] Leat, W. M, Narthrop, C. A., Hamson, F. A.and Cox, R.W. (1983). Effect of Dietary Linoleic and Linolenic Acids On Testicular Development in The Rat. Quarterly Journal of Experimental Physiology, 68(2), 221-231.

[27] Muibat, O.B., Temitope, L.A., Deborah, O.A. and Abdullcabor, O.O. (2011). Physicochemical Properties and Fatty Acid Profile of Seed Oil of Telfairiaoccidentalis Hook F. International Journal of Basic and Applied Science, 11(06), 9-14.

[28] Nahm, H.S. (2011). Quality Characteristics of West African Shea butter (Vitellaria Paradox) and Approaches to Extend Shelf-Life. Retrieved from https://rucore.libraries.rutgers.edu. 11th May, 2017.

[29] Nielson, S. S. (1994). Introduction to the chemical Analysis of Foods. Chapman and Hall, New York, USA, pp. 93-207.

[30] NIS, (1992). Nigerian Industrial Standards (NIS 289). Standard Organization of Nigeria, Standard for Edible Vegetable Oil. Lagos, Nigeria: Essential Communications Ltd.

[31] Nkang A., Omokaro A., Egbe A. andAmanke, G. (2003). Variation of Fatty AcidProportion During Desiccation of T. Occidentalis Seeds Harvested at Physiological and Agronomic Maturity. African Journal of Biotechnology,2(2), 33-39.

[32] Nwabanne, J.T. (2012). Kinetics and Thermodynamics Study of Oil Extraction from Fluted Pumpkin Seed. International Journal of multidisciplinary Sciences and Engineering, 3(6), 11-15.

[33] Nwabanne, J.T. (2012). Kinetics and Thermodynamics Study of Oil Extraction from Fluted Pumpkin Seed. International Journal of multidisciplinary Sciences and Engineering, 3(6), 11-15.

[34] O'Brien, R.D. (2004). Fats and Oil. Formulating and processing for Application, 2nd ed. Lancester: Technomic Publishing Co. Inc.

[35] Oboh, G.,Nwanna, E.E. and Elusiyan, C.A. (2006). Antioxidant and Antimicrobial Properties of Telfairiaoccidentalis (Fluted pumpkin) Leaf Extracts. Journal of Pharmacology and Toxicology, 1, 167-175.

[36] Odoemena, C.S. and Onyeneke, E.C. (1998). Lipids of Fluted Pumpkin (Telfairiaoccidentalis) Seeds. Proceedings of the 1st African Conference on Biochemistry of

Lipids (pp. 147-151). Benin City, Nigeria: AmbikPress.

[37] Okashi, V.E., Oguga, V.N., Ugian, E.A. and Njoku, O.U. (2013). Physico-Chemical Properties of Fluted Pumpkin (Telfariaoccidenttalis Hook F) Seeds. The International Journal of Engineering and Science, 2(9), 36-38.

[38] Okoli, B. E. and Nyanayo, B.C. (1988). Polymology of Telfairia L. (Cucurbitacea) Folia.Geobotanica andphytotaxonomica, 23, 281-286.

[39] Ononogbu, I. C. (2002). Lipid in Human Existence. Ap Express, Nsukka pp. 1-80.

[40] Shahidi, F. (2005). Quality Assurance of Fats and oils. In: Bailey's Industrial oil and fats products, Shahidi, F. (Ed). 6A Edn. John Wily and Sons Inc., USA.

[41] Stevenson, D.G., Eller, F.J., Wang, J.L., Wang, T. and Ingleth, G.E. (2007). Oil and Tocopherol Content and Composition of Pumpkin Seed Oil in 12 Cultivars. Journal of Agriculture and Food Chemistry, 55, 4005-4013.