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Comparative physico-chemical and proximate analysis of oils of Shea nut, *Sesamum indicum*, *Cucurbita pepo*, *Cucumis melo* seeds commonly cultivated in West Africa

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In rural areas of developing countries like Burkina Faso, nutritive elements are mainly composed of vegetable source. Shea nut, seeds of *Sesamum indicum*, *Cucumis melo* and *Cucurbita pepo,* four species widely consumed were studied. The proximate parameters: moisture, proteins and fat were analysed. Saponification value, iodine value, acid value and peroxide value of selected nut and seeds oils and fatty acids were also evaluated. The results for moisture content of oils were significantly different (P<0.05) and ranged between 3.22 ± 0.36 to 6.74 ± 0.83%. Protein rate was ranged between 12.93 ± 2.60 to 19.96 ± 0.73 with significant difference (P<0.05). Fat content was ranged at significant difference (P<0.05) as 49.14 ± 0.06, 43.82 ± 0.12, 42.01 ± 0.20 and 41.07± 0.73 for *S. indicum*, shea nut, *C. melo and C. pepo*, respectively. The acid value obtained from *S. indicum*, *C. pepo*, *C. melo* ranged between 2.51 ± 0.13, 1.29 ± 0.05 and 1.16 ± 0.06 mg/KOH/g, respectively with significant difference (P<0.05). The iodine value of the oil samples showed significant difference (P<0.05). The significant difference (P<0.05) of saponification value ranged between 197.4 ± 0.70, 191.8 ± 2.23, 117.13 ± 2.37 and 112.54 ± 0.03 from shea nut, *S. indicum*, *C. pepo* and *C. melo*, respectively. The different samples showed significant difference (P<0.05) of peroxide value ranged between 6.5 ± 0.18, 3.38 ± 0.20, 1.45 ± 0.02 and 1.33 ± 0.15 from shea nut, *S. indicum*, *C. melo, C. pepo*, respectively. The composition of fatty acids of oils revealed the presence of high amount of linoleic acid 59.12 ± 1.91 and 62.97 ± 0.62%.

Key words: Shea nut, sesame, cucurbitaceae, oil, physico-chemical, fatty acids.

INTRODUCTION

Most developing countries are confronted with protein-energy malnutrition problem in a large part of the population. Thus, while food supplies have increased between 1969-1971 and 1990-1992, the availability of

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protein and fat, decrease from 53 g / day and 30 g / day to 7 g / day (FAO/WHO, 1996). The United Nations Millennium Summit (UNICEF, 1990) made hunger eradication its first development goal (MDG), adopting the main objective of the 1996 World Food Summit; to reduce the number of undernourished people to half their present level no later than 2015 (Haddad et al., 2004). However, the United Nations Food and Agriculture Organization (FAO) estimates that 925 million persons suffer from hunger and malnutrition mainly affects Asia, South America and Africa, including 239 million people in sub-Saharan Africa (Codex, 1993b).

In Burkina Faso, a Sahelian country with about 17 million people, nearly 90% live in rural areas (UNICEF, 1990). Foods such as meat, fish and dairy products are traditional sources of protein; they are expensive and are not usually accessible to most of population.

Seeds are an alternative to protein-energy malnutrition problem due to their high fat and some protein (Bahkali et al., 1998; Egbekun and Ehieze, 1997; Rocquelin et al., 1998). It is therefore necessary to seek and diversify the sources of proteins and lipids by studying the nutritional value and the valuation of some local oil seeds such as Shea butter, sesame and some species of *Cucurbitaceae.* Shea nut fat is composed principally of triglycerides (triacylglycerols) containing an oleic acid moiety at the 2-position and saturated fatty acids, usually stearic or palmitic acids, at the 1- and 3-positions (Acquaye et al., 2001). Sesame is an important export crop in Burkina Faso and has a substantial role in the global sesame trade. The cucurbits are cultivated in different regions of the world and palatable fruits are eaten either raw (*Cucumis melo*) or cooked (*Cucurbita pepo*) with flavour. Similar to these, the seeds of cucurbits, especially pumpkin (*C. pepo* and *Cucurbita maxima*) are a common snack food in several countries and have also been used in food (Dvorkin and Song, 2002; Applequist et al., 2006).

Melon (*C. melo L.*) is a commercially important fruit crop that is cultivated worldwide (Gonzalez-Ibeas et al., 2011). It is also an important summer vegetable crop especially in the rice fallows of Kerala (Rakhi and Rajamony, 2005). Culture and use of cucurbits or squashes (*C. pepo*) have been traced to more than 10000 years ago (Idouraine et al., 1996).

The oils of *C. pepo, Brachystegia eurycoma, C. melo* and *Luffa cylindrica* seeds are generally known as nonedible oils even though some of the seeds are consumed sparingly in some localities, while that of *Arachis hypogaea* are exported on a large scale as edible oil. *C. pepo* L. produces a lot of biomass and its nutrient requirements are generally considered to be high particularly nitrogen and phosphorus (Obalum et al., 2012). Optimal mineral nutrition is fundamental to the growth and productivity of plants (Liu et al., 2010). The optimum doses of nitrogen, phosphorus and potassium vary greatly with the length of growing season, fertility status of soil, soil type, cultivar, geographical location and the environmental factors.

Seed oils are important sources of nutritional oils, industrial and pharmaceutical importance (Nzikou et al., 2010). There are numerous vegetable oils derived from various sources. These include the popular vegetable oils: the foremost oilseed oils - soybean, cottonseed, peanuts and sunflower oils; and others such as palm oil, palm kernel oil, coconut oil, castor oil, rapeseed oil and others (Nzikou et al., 2010). They also include the less commonly known oils such as *C. melo*, *C. pepo* oil and numerous others. Their yields, different compositions and by extension their physical and chemical properties determine their usefulness in various applications aside edible uses (Aluyor and Ori-Jesu, 2008). The characteristics of oil from different sources depend mainly on their composition and no oil from a single source can be suitable for all purposes (Mohammed and Jorf-Thomas, 2003).

This study was therefore undertaken to chemically analyze oils extracted from Shea nut, seed of *S. indicum, C. pepo Linn.* and *C. melo* and compare their quality with Codex standard values for food usage.

MATERIALS AND METHODS

This study was carried out in the Centre of Research in Biological, Food and Nutrition Sciences, Department of Biochemistry and Microbiology, University of Ouagadougou.

Sampling

Shea nut, was collected at Banfora (450Km of Ouagadougou) and seeds of *C. pepo*, *C. melo* and *S. indicum* were purchased at Ouagadougou (12°46'N, 129'W, altitude 301 m). The choice has been based on their availability, and their use to food ends. The plants were identified and authenticated by a Botanist at the Plants Biology Department, Ouagadougou University, Burkina Faso. Good nut and seeds were carefully selected, cleaned, shelled, well dried and crushed using laboratory Electric grinder prior to extraction.

Oil extraction

The extraction of 5.0 g of ground seed and nut was conducted in a Soxhlet extractor using n-hexane (boiling point of 40-60°C) for 6 h using adapted method of Warra et al. (2012). The oils were obtained after the solvent was shaken in reduced temperature and pressure and refluxing at 70°C to rid excess solvent used in the oil. Extracted nut and seed oil were stored in freezer at -2°C for subsequent physico-chemical analysis.

Physico-chemical analysis

Determination of moisture content

Moisture content by the oven dry method was used. Five grams of crushed sample was dried in the oven 105 ± 2°C for 5 h. The weight difference shows the moisture content (AOAC, 1990).

Determination of protein

This was measured following the Kjeldahl method based on the total mineralization of the biological material in an acid environment, followed by distillation of nitrogen in ammonia form (AOAC, 1990). The total mass of vegetable protein is calculated using a conversion factor of 6.25.

Determination of fats

A quantity of 5 g of each sample was weighed and introduced into an extraction cartridge, and covered by cotton. The cartridge was placed in a 150 ml glass Soxhlet (AOCS, 1990). The solvent container was weighed and 400 ml of n-hexane was added. The soxhlet was then introduced into the container placed on the heating mantle, which was then connected to the cryostat cooling thermostat. Four to six siphoning processes were conducted for 5 h. The heating mantle was disconnected. The solvent was evaporated in a RE 121 Rotavapor (made in Switzerland). The container with the fat was placed in an oven for 4 h at 103°C, and then in a desiccator for 30 min and weighed. The weight difference gives the fat content of the sample.

Determination of acid, iodine, peroxide and saponification value of oils extracted

The chemical analysis of the oils was carried out using the methods reported as AOAC, 1998; Akpan et al., 2006.

Acid value: A volume of 100 ml of neutral ethyl alcohol was heated with 10 g of oil or fat sample in a 250 cm^3 beaker until the mixture began to boil. The heat was removed and was titrated with N/10 KOH solution, using two drops of phenolphthalein as indicator with consistent shaking for which a permanent pink colour was obtained at the end point.

The Acid value was calculated using the expression;

$$AV = 0.56 \times \text{No. of ml. N/10 KOH used}$$

Iodine value: A Quantity of 0.4 g of the sample was weighed into a conical flask and 20 cm^3 of carbon tetra chloride was added to dissolve the oil. Then 25 cm^3 of Dam's reagent was added to the flask using a safety pipette in fume chamber. Stopper was then inserted and the content of the flask was vigorously swirled. The flask was then placed in the dark for 2 h 30 min. At the end of this period, 20 cm^3 of 10% aqueous potassium iodide and 125 cm^3 of water were added using a measuring cylinder. The content was titrated with 0.1 M sodium thiosulphate solutions until the yellow color almost disappeared.

Few drops of 1% starch indicator was added and the titration continued by adding thiosulphate drop wise until blue coloration disappeared after vigorous shaking. The same procedure was used for blank test and other samples. The iodine value (I.V) is given by the expression:

$$IV = 12.69C (V_1 - V_2)/M$$

Where, C = Concentration of sodium; V_1 = volume of sodium thiosulphate used for blank; V_2 = volume of sodium thiosulphate used for determination and M = mass of the sample.

Saponification value: A quantity of 2 g of the oil sample was added to a flask with 30 cm^3 of ethanolic KOH and was then attached to a condenser for 30 min to ensure the sample was fully dissolved.

After sample had cooled, 1 cm^3 of phenolphthalein was added and titrated with 0.5 M HCl until a pink endpoint has reached. Saponification value was calculated from the equation:

$$SV = (S-B) \times M \times 56.1/\text{Sample weight (g)}$$

Where, S = sample titre value; B = blank titre value; M = molarity of the Hcl; 56.1 = molecular weight of KOH

Peroxide value: Peroxide value has been determined according to the AOCS methods, 1990 (AOAC 965.33).

Determination of the composition in fatty acids by the gas-liquid chromatography

The samples were previously mixed with methyl to the proportion of 200 mg of lipids for 10 ml of the hydrochloric methanol mixture (25 ml of chloride of acetyl in 250 ml of methanol). After dilution, the fat phase was extracted with 20 ml of hexane, then washed until neutrality, concentrated by evaporation and dried to the sulphate of sodium.

The prepared samples were injected into the chromatograph to ionize the flame marks Girdel 30, provided with a column carbowax 20 M and with a recording Shumadzu CR4A. The methylic esters were identified by comparison with a chromatogram standard achieved with fatty acids of reference. The conditions of analysis were as follows: Temperature of the oven: 180°C; Temperature of the injector: 220°C; temperature of the detector: 260°C; vector gas: nitrogen; pressure of entry of the vector gas: 2.5 bars; debit of the vector gas: 1.65 ml/min; debit of the gas of food of the detector to ionization of flame (FID): air: 75.5 ml/min. hydrogen: 8.5 ml/min.

Statistical analysis

All experiments were conducted in triplicate and the statistical significance differences of mean were calculated using SAS (20.1), with the help of one-way ANOVA. Results are expressed as means ± SD. A probability value at $p<0.05$ was considered to denote the statistically significant differences.

RESULTS AND DISCUSSION

The results obtained from the experimental work are presented in Tables 1 and 2. The tables include results of as well as the physical and chemical compounds of the extracted oil as well as the fatty acid profile.

The results in table 1 showed that moisture content of oils were significantly different ($P<0.05$) and ranged between 6.74 ± 0.83, 4.6 ± 0.11, 4.32 ± 0.37 and 3.22 ± 0.36% shea nut, *C. pepo*, *S. indicum*, *C. melo* respectively. They were very high, far exceeding that of *A. hypogaea* oil (0.089%) and also the stipulated Codex standard (0.05%). This high moisture content creates problem in trans esterification.

Protein rate ranged between 12.93 ± 2.60 and 19.96 ± 0.73 with significant difference ($P<0.05$). In the seed of *S. indicum*, protein was higher than all seeds and nuts. This indicates that these could be used for food enrichment and against malnourishment.

Table 1. Physicochemical characteristics of the oils of shea nut, *Sesamum indicum*, *Cucurbita pepo*, *Cucumis melo* seeds.

Parameter	Shea nut	*Sesamum indicum*	*Cucurbita pepo*	*Cucumis melodrama*
Moisture (g/100 g)	6.74 ± 0.83[a]	4.32 ± 0.37[b]	4.6 ± 0.11[b]	3.22 ± 0.36[c]
Protein (g/100 g)	12.93 ± 2.60[a]	19.96 ± 0.73[b]	18.87 ± 1.50[c]	18.60 ± 0.02[c]
Fat (g/100 g)	43.82 ± 0.12[a]	49.14 ± 0.06[b]	41.07 ± 0.73[c]	42.01 ± 0.20[c]
Acid value (mgKOH/g)	11.17 ± 1.62[a]	1.16 ± 0.06[b]	1.29 ± 0.05[b]	2.51 ± 0.13[c]
Iodine value (mg I2/100 g)	54.14 ± 1.19[a]	108.28 ± 3.11[b]	95.55 ± 0.16[c]	76.34 ± 2.6[d]
Saponification value (mgKOH/g)	197.4 ± 0.70[a]	191.8 ± 2.23[b]	117.13 ± 2.37[c]	112.54 ± 0.03[d]
Peroxide value (meqO_2/kg)	6.5 ± 0.18[a]	3.38 ± 0.20[b]	1.33 ± 0.15[c]	1.45 ± 0.02[c]

Means with different letters on row are significantly different at P = 0.05.

Table 2. Fatty acid composition (g/100g) of oils extracted from four plants.

Free fatty acid	Shea nut	*Sesamum indicum*	*Cucurbita pepo*	*Cucumis melo*
Palmitic acid C16 : 0	3.65 ± 0.28[a]	11.92 ± 0.58[b]	10.50 ± 0.70[b]	8.18 ± 0.49[c]
Palmitoleic acid C16 : 1	-	0.23 ± 0.12	-	-
Stearic acid C18 : 0	42.87 ± 0.7[a]	5.18 ± 0.20[b]	8.89 ± 0.73[c]	12.43 ± 1.00[d]
Oleic acid C18 : 1	42.91 ± 1.2[a]	41.20 ± 1.13[a]	17.22 ± 1.12[b]	18.11 ± 0.74[b]
Linoleic acid C18 : 2	6.85 ± 0.20[a]	37.37 ± 0.88[b]	62.97 ± 0.62[c]	59.12 ± 1.91[c]
Ratio unsaturated/saturated	1.13[a]	4.60[b]	4.15[b]	3.75[c]

Means with different letters on row are significantly different at P = 0.05.

Fat content ranged with significant difference (P<0.05) as 49.14 ± 0.06, 43.82± 0.12, 42.01 ± 0.20 and 41.07 ± 0.73 for *S. indicum*, Shea nut, *C. melo, C. pepo* respectively.

An Acid value was ranged from 1.16 ± 0.06 to 11.17 ± 1.62 mgKOH/g with significant difference (P<0.05). Highest value was obtained in oil of the Shea nut (11.17 ± 1.62 mgKOH/g) which is lower than that of olive oil 17 mgKOH/g (Oyedele, 2006), higher than Codex Stan 19-(1993a) acceptable value (4 mg/KOH/g).

The acid values obtained from *S. indicum*, *C. pepo*, *C. melo* ranged between 2.51 ± 0.13, 1.29 ± 0.05 and 1.16 ± 0.06 mg/KOH/g; were lower than Codex STAN 19-(1993a) limit value (4 mg/KOH/g) and those obtained by Eka and Chidi (2009) for butternut oil and Akubugwo and Ugbogu (2007) for African star apple oil which reported acid values of 4 for sesame, soybean, sunflower and rape seed and 7 for olive oil.

Acid value is a direct measure of the percentage content of free fatty acids in a given amount of oil. It is a measure of the extent to which the triglycerides in the oil have been decomposed by lipase action into free fatty acids; acid value depends on the degree of rancidity which is used as an index of freshness (Ochigbo and Paiko, 2011). It is common knowledge that these parameters are a measure of the level of spoilage of oil, hence we conclude that they are of low magnitude and a reflection of the freshness and edibility of the crude oil.

The iodine value of oil of samples showed significant difference (P<0.05). The values obtained on extracted oils of *S. indicum*, *C. pepo*, *C. melo* and Shea nut were 108.28 ± 3.11, 95.55 ± 0.16, 76.34 ± 2.6 and 54.14 ± 1.19 mg I_2/100 g respectively. *S. indicum* iodine value was in agreement with critical value (104-120 mg I2/100 g) of Codex Stan 26 (1993a). All of samples were higher than 31.06 ± 0.80 mg/100 g found from previous work on African star apple seed by Akubugwo and Ugbogwu (2007). Oils are classified into drying, semi-drying and non-drying according to their iodine values. The iodine value of *C. pepo*, *C. melo* seeds, Shea nut oil is lower than 100, it could only be classified as a non-drying oil. The low iodine value indicates that the oil has a low content of unsaturated fatty acids thus resembles olive oil and groundnut oil, could be employed for food and other use (Dosunmu and Ochu, 1995).

The significant difference (P<0.05) of saponification value ranged between 197.4 ± 0.70; 191.8 ± 2.23, 117.13 ± 2.37 and 112.54 ± 0.03 from Shea nut, *S. indicum*, *C. pepo* and *C. melo* respectively.

Shea nut and *S. indicum* compared favourably with values obtained by Mohammed and Hamza (2008) for sesame seed (189 to 190 mg/KOH/g) and some common oils like palm oil (196-205 mg/KOH/g), groundnut oil (188-196 mg/KOH/g), corn oil (187-196 mg/KOH/g) also Codex Stan, 1993a (187-195 mg KOH/g). They were lower than that of coconut oil (253 mg/KOH/g) and palm kernel oil (247 mg/KOH/g). According to Ezeagu et al. (1998) a saponification value of 200 mg KOH/g indicates

high proportion of fatty acids of low molecular weight. This shows that the oil may have a potential for use in soap making and cosmetics industry and for the thermal stabilization of poly vinyl chloride (PVC). These properties make them useful as sources of essential fatty acids required in the body (Akanni et al., 2005). However, saponification values obtained are within the range for edible oils reported by Eromosele et al. (1994).

The different samples showed significant difference (P<0.05) of peroxide value ranging between 6.5 ± 0.18, 3.38 ± 0.20, 1.45 ± 0.02 and 1.33 ± 0.15 from *Shea nut, S. indicum*, *C. melo, C. pepo* respectively. These values obtained were lower than limited value (10 meq/Kg) of Codex Stan 19, (1993a). Peroxide value is an index of rancidity, thus the high peroxide value of oil indicates a poor resistance of the oil to peroxidation during storage (Mohammed and Hamza, 2008). The peroxide values of African star apple seeds are 1.57 meq/KOH/g which is below the maximum acceptable value of 10 meq/KOH/g set by the Codex Alimentarius Commission for such oils as groundnut seed oils (Abayeh et al., 1998). *C. melo* and *C. pepo* were in agreement with the seed oil of cultivated cucurbits from Egypt contained 3.21-3.60 meq/kg of peroxide value (El-Adawy and Taha, 2001). Peroxide value is an indication of deterioration of oil level. The low peroxide value further confirms the stability of the oil. Fresh oils have values less than 10meq/kg. Higher values between 20 and 40 results to a rancid taste (Akubugwo and Ugbogu, 2007). The low acid and peroxide values are indicators of the ability of the oil to resist lypolitic hydrolysis and oxidative deterioration (Akanni et al., 2005).

Fatty acids composition of four plants seed and nut oils as analyzed by gas chromatography is presented in Table 2. Palmitic acid was found significantly different (P<0.05) according to the oils source and ranged from 3.65 ± 0.28 to 11.92 ± 0.58%. Recommended value of Codex Stan 26 (1993a) is 7-12%. *S. indicum* expressed the highest percentage palmitic acid and contained also palmitoleic acid as 0.23 ± 0.12% and was lower than codex stan 26 (1993a) value (<0.25%). Stearic acid detected with significant different (P<0.05) in the tested oils was 42.87 ±0.7, 12.43 ± 1.00, 8.89 ± 0.73 and 5.18 ± 0.20 from Shea nut*, C. melo C. pepo* and *S. indicum* respectively. Recommended value of Codex Stan 26 (1993a) is 3.5 -6.0%. The range of oleic acid and linoleic acid were 17.22 ± 1.12% to 42.91 ± 1.2% and 6.85 ± 0.20 to 62.97 ± 0.62 with significant difference (P<0.05) between the oils. *C. melo and C. pepo* expressed the highest percentage of linoleic acid. Ratio unsaturated/ saturated showed higher value (4.60) has been observed in oil of *S. indicum seed.* Previously, Sew et al. (2010) also found that winter melon seed oil had linoleic acid (67.37%) as the principal component, followed by palmitic acid (17.11%), oleic acid (10.21%) and stearic acid (4.83%), respectively. *C. melo and C. pepo* seed oils could be explored as a potential source of omega 6 dietary supplements.

The concentration of major fatty acids as studied in the present work could be comparable with other cucurbits seed oils. *Cucumeropsis manni* seed oil had a range of 15-24, 10-12.3, 9-18 and 42-61% of palmitic acid, stearic acid, oleic acid and linoleic acid, respectively (Badifu, 1991; Fokou et al., 2009). *C. pepo* seed oil contained fatty acids compound within a range of 9.9-49.2% (palmitic acid), 4.87-11.2% (stearic acid), 17.0-47.0% (oleic acid), and 4.9-55.6% (linoleic acid) (Tsaknis et al., 1997, El-Adawy and Taha, 2001, Nakic et al., 2006; Nyam et al., 2009). Palmitic acid (10.7-11.36%), stearic acid (7.04-9.00%), oleic acid (13.25-18.1%) and linoleic acid (59.6-68.3%) were detected as the most abundant fatty acids in *Citrullus lanatus* seed oils (El-Adawy and Taha, 2001; Milovanovic and Picuric-Jovanovic, 2005; Mariod et al., 2009, Nyam et al., 2009; Baboli and Safe Kordi, 2010).

Conclusion

The extracted seed oils revealed the presence of high amount of linoleic acid (59.12 -62.97%) in *C. pepo* and *C. melo,* placing these oils in the category of high-linoleic vegetable oils. The proximate analysis of seeds and physicochemical attributes of the extracted seed oils were appraised for the four grown in West Africa. The seeds and nut from the tested plants were explored as a good source of oil, protein and thus could be consumed for dietary purposes. Further investigation on tocopherol and phytosterol amount of the seed and nut oils is strongly recommended.

Conflict of interests

The authors did not declare any conflict of interest.

REFERENCES

Abayeh OJ, Aina EA, Okounghae CO (1998). Oil Content and Oil Quality Characteristics of some Nigerian Oils Seeds. Science Forum: J. Pure Appl. Sci. 1(1):17-23.

Acquaye D, Smith M, Letchamo W, Angers P, Simon J (2001). Shea butter. Agrobusiness in Sustainable Natural African Plant Products pp. 1-2.

Akanni MS, Adekunle SA, Oluyemi EA (2005). Physico-chemical properties of some non-conventional oil seed. J. Food Technol. 3:177-181.

Akpan UG, Jimoh A, Mohammed AD (2006). Extraction, characterization and modification of castor seed oil. Leonardo J. Sci. 8:43-52.

Akubugwo IE, Ugbogwu AE (2007). Physicochemical Studies on Oils from Five Selected Nigerian Plant Seeds. Pak. J. Nutr. 6(1):75-78.

Aluyor EO, Ori-Jesu M (2008). The use of antioxidants in vegetable oils. Afr. J. Biotechnol. 7(25): 4836-4842.

AOAC (1990). Official Methods of Analysis. 15th Ed, Association of Official Analytical Chemists, Washington DC. pp. 808,831-835,1113.

AOAC (1998). Official Methods of analysis of the Association of Official Analytical Chemists, 16th Ed. Gaithersburg, USA.

AOCS (1990). Official Methods and Recommended Practices. 4th Ed.http://www.aocs.org.

Applequist WL, Avula B, Schaneberg BT, Wang YH, Khan IA (2006). Comparative fatty acid content of seeds of four *Cucurbita* species grown in a common (shared) garden. J. Food Compost. Anal. 19:606-611.

Baboli MZ, Safe Kordi AA (2010). Characteristics and composition of watermelon seed oil and solvent extraction parameters effects. J. Am. Oil Chem. Soc. 87:667-671.

Badifu GIO (1991). Chemical and physical analysis of oils from four species of *Cucurbitaceae.* J. Am. Oil Chem. Soc. 68(6):428-432.

Bahkali AH, Hussain MA, Basahy AY (1998). Protein and oil composition of sesame seeds (*Sesamum indicum*, L.) grown in the Gizan area of Saudi Arabia. Internatio. J. Food Sci. Nutr. 49:409-414.

Codex Alimentairus Commission (1993a). Graisses et huiles vegetables, division 11. Version Abregee FAO/WHO Codex Stan 1993, 20-1981, 23-1981, 1993.

Codex alimentarius (1993b). Fats, oils and related products. 2nd ed., Rome, FAO/WHO, 133p.

Dawodu FA (2009). Physico-chemical studies on oil extraction processes from some Nigerian grown plant seeds. Elect. J. Env. Agric. Food Chem. 8(2):102-110.

Dvorkin L, Song KY (2002). Herbs for benign prostatic hyperplas. Ann. Pharmacother. 36:1443-1452.

Egbekun MK, Ehieze MU (1997). Proximate composition and functional properties of fullfat and defatted benseed (*Sesamum indicum*, L.) flour. Plant Foods Hum. Nutri. 51:35-41.

Eka BE, Chidi EA (2009). Physico-chemical characterisation of Butternut (Jugulans Cinerea) oil. GIobal Pure and Appl. Sci. 15(3):340-344.

El-Adawy TA, Taha KM (2001). Characteristics and composition of different seed oils and flours. Food Chem. 74:47-54.

Eromosele IC, Eromosele CO, Akintoye AO, Komolafe TO (1994). Characterization of oils and chemical analysis of the seed of wild plants. Plant Foods Hum. Nutri. 46:361-365.

Ezeagu IE, Petze KJ, Lange E, Metges CC (1998). Fat content and fatty acid composition of oils extracted from selected wild gathered tropical plant seeds from Nigeria. J. Am. Oil Conten. 75(8):1031-1035.

FAO/WHO (1996). Les graisses et les huiles dans la nutrition humaine. Rapport d'une consultation mixte d'experts OMS/FAO, 57, 142 p.

Fokou E, Achu MB, Kansci G, Ponka R, Fotso M, Tchiegang C, Tchouanguep FM (2009). Chemical properties of some *Cucurbitaceae* oils from Cameroon. Pakistan J. Nutr. 8(9):1325-1334.

Gonzalez-Ibeas D, Donaire J, Blanca L, Saladié M, Mascarell-Creus A, Cano-Delgado A (2011). Analysis of the melon (*Cucumis melo*) small RNAome by high-throughput pyrosequencing. Ibadan, Nigeria. BMC Genomics 12:393-406.

Haddad L, Ross J, Oshaug A, Torheim LE, Cogill B (2004). Fifth Report on the World Nutrition Situation: Nutrition for Improved Development Outcomes. United Nations, Standing Committee on Nutrition. SCN (United Nations Standing Committee on Nutrition), Geneva. 143 p.

Idouraine A, Kohlhepp EA, Weber CW (1996). Nutrient constituents from eight lines of naked seed squash (*Cucurbita pepo L.).* J. Agric. Food Chem. 44(3):721-724.

Mariod AA, Ahmed YM, Matthäus B, Khaleel G, Siddig A, Gabra AM, Abdelwahab SI (2009). A comparative study of the properties of six sudanese cucurbit seeds and seed oils. J. Am. Oil Chem. Soc. 86:1181-1188.

Milovanovic M, Picuric-Jovanovic K (2005). Characteristics and composition of melon sees oil. J. Agric. Sci. 50(1):41-47.

Mohammed MI, Hamza ZU (2008). Physico-chemical properties of oil extracts from *Sesamum indicum L.* Seeds grown in Jigawa State-Nigerian. J. Appl. Sci. Environ. Manag. 12(2):99-101.

Mohammed RF, Jorf-Thomas M (2003). Determination of the lipid classes and fatty acid profile of Niger seed (*Guizotia abyssinica Cass*). Phytochem. Anal. 14:366-370.

Nakic SN, Rade D, Skevin D, Strucelj D, Mokrovcak Z, Bartolic M (2006). Chemical Characteristics of Oils from Naked and Husk Seeds of Cucurbita pepo L. Eur. J. Lipid Sci. Technol. 108:936-943.

Nyam KL, Tan CP, Lai OM, Long K, Che Man YB (2009). Physico-chemical properties and bioactive compound of selected seed oils. LWT-Food Sci. Technol. 42(8):1396-1403.

Nzikou JM, Mvoula-tsiéri M, Ndangui CB, Pambou-Tobi NPG, Kimbonguila A, Loumouamou B, Silou Th, Desobry S (2010). Characterization of Seeds and Oil of Sesame (*Sesamum indicum* L.) and the kinetics of degradation of the oil during heating. Res. J. Appl. Sci. Eng. Technol. 2(3):227-232.

Obalum SE, Buri MM, Nwite JC, Hermansah L, Watanabe Y, Igwe CA, Wakatsuki T (2012). Soil Degradation-Induced Decline in Productivity of Sub-Saharan African soils: The prospects of looking downwards the lowlands with the Sawah Ecotechnology. Appl. Environ. Soil Sci. 1:1-10.

Ochigbo SS, Paiko YB (2011). Effects of Solvent Blending on the Characteristics of Oils Extracted from the Seeds of *Chrysophyllum albidium.* Internat. J. Sci. Nat. 2(2):352-358.

Oyedele AO (2002). The Skin Tolerance of Shea Fat Employed as Excipient in Topical Preparations. Niger. J. Nat. Prod. Med. 66:26-29.

Rakhi R, Rajamony L (2005). Variability, heritability and genetic advance in landraces of culinary melon (Cucumis melo L.). J. Trop. Agric. 43(1-2):79-82.

Rocquelin G, Tapsoba S, Mbemba F, Gallon G, Picq C (1998). Lipid content and fatty acid composition in foods commonly consumed by nursing Congolese women: incidences on their essential fatty acid intakes and breast milk fatty acids. Int. J. Food Sci. Nutr. 49:343-352.

Sew CC, Zaini NAM, Anwar F, Hamid AA, Saari N (2010). Nutritional composition and oil fatty acids of kundur [*Benincasa hispida (Thunb.) Cogn*.] seed. Pak. J. Bot. 42(5):3247-3255.

Tsaknis J, Lalas S, Lazos ES (1997). Characterization of crude and purified pumpkin seed oil. Grasas y Aceites 48(5):267-272.

UNICEF (1990). Sommet Mondial pour les Enfants," Nations Unies, New York, 29-30 September 1990.

Warra AA, Wawata IG, Umar RA, Gunu SY (2012). Soxhlet extraction, Physicochemical Analysis and Cold process saponification of Nigerian *Jatropha curcas* L. Seed oil. Can. J. Pure Appl. Sci. 6(1):1803-1807.