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Taxonomic analyses and evaluation of the physico-chemical properties of seed-oils in some species of the family 'Cucurbitaceae'

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Abstract

The family *Cucurbitaceae* consisting of many economic plants (squashes, melons, cucumber, pumpkins, luffas, and watermelons) is faced with the problem of proper classification based on the use of few morphological characters. There is therefore the need to employ many more taxonomical characters to give a broad based classification using seed-oil characters. The objectives of the study were to identify and determine the physical properties of seed-oils; elucidate taxonomic Relationships through numerical analysis of these oils in the selected species of the family. Seeds from fourteen species of *Cucurbitaceae* were collected from various locations in Osun and Kwara States, Nigeria and were identified in the Forestry Herbarium, Ibadan and Herbaria of Universities of Ibadan and Ilorin. Two grams of oil were extracted from the seeds of each species with Soxhlet extractor using Petroleum ether at 60-80°C. The physicochemical properties of the samples were investigated using Standard Procedures of Association of Official Analytical Chemists while the fatty acid compositions were determined using Gas Chromatography 7890 and Mass Spectrophotometer VL 597SC and Injector 7683B. The pH values, Specific gravity, and refractive index value ranged from 5.02-6.80, 0.87-0.96 and 1.46-1.48 respectively. The Acid, Iodine, and Peroxide values ranged from 1.21-18.16mgKOH/g, 0.62-126.40 and 1.26-18.74mg/g respectively. The Saponification values were between 115.92 and 210.52mgKOH/g except for *Lagenaria siceraria* (flask shaped), *L. siceraria* (spherical) and *L. cylindrica* which had saponification values of 22.08 mgKO H/g, 66.77mgKOH/g and 66.81 mgKOH/g respectively. Significant differences ($p \leq 0.05$) existed among the species based on physicochemical analysis. Seed-oil characters complemented morphological features in identification of varieties and species in the family. The study concluded that seed-oils were found to be good taxonomic characters and are recommended for use in solving problem of classification in the family *Cucurbitaceae.*

Keywords: Taxonomy, Morphological characters, Herbarium, Saponification, seed oil

1.0 Introduction

The family *Cucurbitaceae* includes a large group of plants like squashes, melons and gourds, with crops like Cucumber, pumpkins, luffas and watermelons. Most crops belonging to this family are referred to as cucurbits. They are mostly annual vines with some woody lianas, thorny shrubs, and trees (*Dendrosicyos*). Many species have large, yellow or white flowers. The stems are hairy and pentangular. Tendrils are present at 90° to the leaf petioles at nodes. Leaves are exstipulate alternate, simple, palmately lobed or palmately compound (Akinsanmi, 1980). The flowers are unisexual, with male and female flowers on different plants (dioecious) or on the same plant (monoecious). The female flowers have inferior ovaries. The fruit is often a kind of modified berry called a Pepo. The *Cucurbitaceae* family has a tremendous genetic diversity, extending to vegetative and reproductive characteristics (Ng, 1993). They grow in tropical, subtropical, arid deserts and temperate locations such as in West Africa. Three seeds are planted per hole at a depth of 3 cm on beds at about 120 – 200 cm between rows and between seeds where they attain maturity in the months of March and April (Akinsanmi, 1980). After planting, they completely cover the soil surface within 4 weeks of growth, and help in weed control. Pollination is by insects. Flowering occurs at about 4-5 weeks. The fruits are indehiscent large and seedy smooth berries, and can be stored for over a year, or the seeds can be removed, washed and dried.

Different percentages of oil from Cucurbit seeds have been reported. Martin (1998) reported that the seeds contain about 50% oil, while Achu *et al.* (2004) indicated 42-57% oil in seeds of cucurbits, Achu, *et al*. (2009) reported 44-54% oil from seeds cultivated in different bioclimatic regions in Nigeria. The uses of Cucurbit seeds as potential sources of oils have been reviewed by Jacks *et al.*, (1972)

who reported that the dehulled seeds contain about 50% of oil. The high content of oil, with useful qualities such as odourlessness, good colour and appearance, make these seeds suitable for oil industrial applications (Al-Khalifa, 1996; Mariod *et al.*, 2009). Cucurbit seed oils mainly consist of palmitic (16:0), stearic (18:0), oleic (18:1 n-9), and linoleic (18:2 n-6 or ω-6) acids. Due to high amounts of polyunsaturated fatty acids, these oils have favourable nutritional status and beneficial physiological effects towards prevention of coronary heart disease and cancer (Yehuda and Rabinovitz, 2005). The aim of this study is to use the results of the physicochemical analysis on the fourteen species for classification of the *Cucurbitaceae.* This study is also envisaged to reveal the fatty acid composition and economic potentials of oil extracted from melon seeds in Nigeria. This will enable the oils to be exploited by industry for alimentary purposes, with the eventual production and use of seed of *Cucurbitaceae* oils. Subsequently, the production, consumption and sale of this seeds especially in the rural areas will increase, thus helping to improve their health benefits and financial status.

2.0 Materials and methods

The seeds were collected from two locations including: Ile-Ife, Osun State, Ilorin, Kwara State, Nigeria (Table 1) and were taken to Forestry Herbarium Ibadan (FHI) and Universities of Ibadan and Ilorin Herbaria for proper identification.

2.1 Extraction of seeds oils

Two grams (2g) of seeds were weighed and dehusked through removal of testas. They were cleaned and sun-dried. After drying, the crushing of the seeds was achieved by pounding with laboratory mortar and pestle. The oil was extracted with soxhlet apparatus using petroleum ether 60-80^{o}C (Biakales, 1978; Cocks and Van Rede, 1996; AOAC, 1990).

2.2 Determination of physical properties

This was carried out in the Chemistry Laboratories, Department of Chemistry, University of Ilorin, Ilorin.

2.2.1 Specific gravity

A Measuring cylinder containing 1cm^{3}of oil was weighed. The volume of oil was determined by subtracting the weight of the empty container from the weight of the container containing the oil. Specific gravity was determined by using the following formula.

Specific gravity=Weight of oil in (g)/Volume of oil (cm^3) (Temple, 1989).

Table 1. List of species of Cucurbitaceae studied

Species	Shape of Fruit	English name	Nigerian local names	Place of collection	Global Positioning System
Citrullus lanatus Thund.	Oblong	Melon	Egusi baara (Y), Ogili (I), Guna (H)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E
Cucumis sativa Linn.	Oblanceolate	Cucumber	Cucunber (Y), Uniokirihio (I), Kokumba (H)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E
Cucumis melo Linn	Oblanceolate	Musk melon	Baara ekute (Y), Egusi (I), Duna/Gurji (H),	Ile-Ife, Osun State	$7^{o}\ 28^{1}\ 0^{11}$ N $4^{o}\ 34^{1}\ 0^{11}$ E
Adenopus breviflorus Benth.	Round	Bitter melon	Tagiri (Y), Anyummuo (I), Gojin jima (H),	Ile-Ife, Osun State	$7^{o}\ 28^{1}\ 0^{11}$ N $4^{o}\ 34^{1}\ 0^{11}$ E
Trichosanthes auguina Lin.	Sphercal	Snake gourd	Tomato elejo (Y), Ogir i(I), Hausa(Guna)	Ile-Ife, Osun State	$7^{o}\ 28^{1}\ 0^{11}$ N $4^{o}\ 34^{1}\ 0^{11}$ E
Cucumeropsis manni Naud.	Round	Melon	Itoro (Y), Ahu elu (I), Hausa (A)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E
Luffa cylindrica Linn.	Cylindrical	Sponge	Kainkain igbo (Y), Asisa (I), Soso (H)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E
Cucurbita pepo Linn.	Oval	Pumpkin	Elegede (Y), Ukoro (I), Kabewa kabo (H)	Ile-Ife, Osun State	$7^{o}\ 28^{1}\ 0^{11}$ N $4^{o}\ 34^{1}\ 0^{11}$ E
Telfairia occidentalis Hook.F.	Cylindrical	Ugwu	Aworoko (Y), Ugu (I), Kabewa (H)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E
Momordica charantia Linn.	Oblong	Bitter melon	Ejinrin (Y), Ale ose (I), Kakayi (H)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E
Lagenaria siceraria Monlina (Standl)	oblong fruit	Bottle gourd	Seere (Y), Ugbogoro (I), Egusiito (H)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E
Lagenaria siceraria Monlina (Standl)	flask-shaped	Bottle gourd	Ato (Y), Ugbogoro (I), Egusiito (H)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E
Lagenaria siceraria Monlina(Standl)	small round fruit	Bottle gourd	Ado(Y), Ugbogoro (I), Egusiito (H)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E
Lagenaria siceraria Monlina (Standl)	spherical fruit)	Bottle gourd	Igba(Y), Ugbogoro (I), Egusiito (H)	Ilorin, Kwara State	$8^{o}\ 30^{1}\ 0^{11}\ 4^{o}\ 33^{1}\ 0^{11}$ E

Keys: Yoruba (Y), Hausa (H), Igbo (I).

2.2.2 Viscosity

This is the ratio of the shear stress to the rate of shear of a fluid. The unit of absolute viscosity is the slope. The Viscosity was determined by placing a suspended level

Viscometer (type bs/IP/SL) in a constant temperature bath while maintaining the Capillary in a vertical position. The viscometer was filled with the seed oil such that the U tube at the bottom filled completely without trapping air. About 15 min. was allowed for the oil to attain the temperature of the bath. The oil was moved by suction to the other arm so that the main meniscus was above the mark at the top of the upper reservoir. The oil was then allowed to flow freely through the capillary tube. The flow time was taken using stop watch. The flow time in capillary viscometer are proportional to kinematic viscosity (Lakshminarayana, *et al.,* 1983).

2.2.3 Refractive index

The Refractive index of oil was taken as the ratio of the Sine of the angle of incidence to the Sine of the angle of refraction when a ray of light of wavelength 589.3 mμ passes from air into the oil (Biakales, 1978). The oil samples were dried and filtered prior to refractive index determinations. A drop of oil was placed in between the Glass prisms provided on the Refractometer. Ample time of about 5 min was allowed for the oil and prisms of the instrument to attain a steady temperature. The knob was well adjusted after which the readings were taken.

2.3 Determination of chemical properties

2.3.1 Acid value

The following solutions employed for the acid value determination was prepared as prescribed by Cocks and Van Rede, (1996).

0.1M KOH solution

Four grammes of KOH were dissolved in 1000cm^3 of distilled water and the solution was kept for a day before use.

Phenolphthalein indicator

This was prepared by dissolving 4g of phenolphthalein in 1000cm^3 of methanol

Eighty cm^3 Neutral solvent of ethanol was measured into a 250cm^3 Volumetric flask and heated by a hot plate for about 1 min to boil away dissolved gases. Few drops of phenolphthalein indicator were added to indicate the completion of neutralization by giving a pale-pink colouration which persisted for few minutes.

One gramme of oil was dissolved in the neutral solvent 0.1m NaOH solution was then used to titrate the solution using Phenolphthalein indicator. The end point was shown by a persistent pale-pink colouration.The acid value was determined using the following formula:

Acid value=5.61 x N x V/W

where:

N=Normality of NaOH used

V=Volume (ml) of NaOH used

W=Weight of sample used

2.3.2 Iodine value

The iodine value was determined using WiJ's method (Cocks and Van Rede, 1996). The reagents were prepared as follows;

WiJ's solution

Eight point seven grammes of iodine crystals (I_2) was weighed and dissolved in 100g of methanol. 7.96g of ICL_3 was dissolved into 50cm^3 glacial acetic acid which was separately added to the two solutions in different flasks. The two flasks were then heated in a bath. Afterwards, the two solution were mixed in a 1000cm^3 volumetric flask and then with more glacial acetic acid.

2.3.3 Potassium iodine solution (10% w/v)

Fifty grammes of Potassium iodine crystals was dissolved in distilled water and made up to the mark in 500m^3 volumetric flask.

2.3.4 Starch solution

A paste of 1g of starch powder was made with little distilled water. One hundred centimeters cube of boiling water was poured into the paste and brought to boiling.

2.3.5 Sodium thiosulphate solution (0.1m)

Fifteen point eight grammes of Sodium trioxosulphate(IV) (NaS_2O_3) crystals was weighed into 1000cm^3 Volumetric flask and 100cm^3 of distilled water was added to dissolve the crystals and then the solution was made up to the mark.

One gramme of seed oil was weighed into a conical flask and 15cm^3 CCl_4 (tetrachloromethane) was added to dissolve the oil. Twentyfive centemeters

cube of Wig's solution was added and the mixture stoppered. This was kept in the dark for 2 h. At the end of this period, 20cm^3 of 10% KI (Potassium iodide) solution and 150cm^3 of distilled water was added to the solution. The solution was then titrated against the Sodium thiosulphate solution to a faint yellow colouration after which 1cm^3 of starch solution was added. Titration was continued until colouration disappeared. A blank titration was also carried out under the same condition.

The iodine value was calculated thus:

Iodine Value=12.69N (B-A)/W (Cocks and Van Rede, 1996).

where:

B=titre value of blank titration

A=titre value of test solution

W=weight of oil

N=normality of thiosulphate solution

2.3.6 Saponification value

The ethanol/potassium hydroxide (KOH) used was prepared as follows: 4g of KOH pellets were dissolved in 500cm^3 ethanol inside a 100cm^3 flask. The solution was then boiled under reflux for about 20min.The ethanol was distilled. 20g of KOH was added to the distilled ethanol. The temperature was then lowered to about 50^{o}C by using ice bath (Cocks and Van Rede, 1996)

2.3.6.1 Method

Ten centimeters cube of ethanolic KOH solution was measured into a volume metric flask after which the flask was heated gently. One gramme of seed oil and 2 drops of phenolpthalein indicator was then liberated against 0.5m HCl to a colourless end point.The blank titration were carried out under the same conditions. The saponification value was calculated from the formula below

Saponification value =5.61 N (B A) (Cocks and Van Rede, 1996).

where

B = volume of HCl used for blank titration

A=volume of HCl used for sample titration

N=normality of HCl

W=sample weight in g.

2.3.7 Free fatty acid

One gramme of seed oil was weighed and dropped into 250ml conical flask containing 50ml Chloroform. After 5 drops of m-cresol indicator had been added the solution was titrated to purple as end point with aqueous 0.05M NaOH.

FFA=1000x0.5xV/W (Cocks and Van Rede, 1996).

where

V=volume of NaOH

W=weight of oil

2.3.8 Acidity/alkalinity (pH)

The pH of the oil sample was measured using a Pre-calibrated pH meter. One gramme of the oil sample was taken and dissolved in 100ml of H_2O to determine the pH value after two hour with digital pH meter.

2.3.9 Peroxide Value

Three grammes of oil was weighed into 250ml conical flask. 10ml chloroform was added to dissolve the oil. Fifteen milliliter acetic acid, 1.0ml KI (Potassium iodide) solutions were mixed and left for 5min in the dark. Thirty mililiter of distilled water was added and 1ml starch indicator was titrated with Sodium thiosulphate.The process was repeated for blank (without oil). Peroxide Value was determined using the following formula:

$$\text{Peroxide Value} = B - A \times 0.1 \times 1000 / W$$

where:

B=blank

A=sample

W=weight

2.3.10 Determination of fatty acid composition

Fatty acids were converted to their methyl esters (FAME) following the method of He and Xia (2007) with a slight modification. Gas chromatography technique was employed for determining the composition of the oils. The Agilent Technologies GC/MS Instrument Agilent 5975 Series MSD version located at University of Ilorin Chemical Engineering Laboratory was used to analyse the fatty acid composition of the Cucurbitaceae seed oils under the following condition: Column type 19091S-433HP-5MS, 325^{0}C (30m x 250µm; 0.25µm film thickness),

automatic injector with injection volume as 1µL.Injection temperature 250^{o}C, interface temperature 300^{o}C Helium carrier gas flow rate was 79.5. 5mL/ min, split ratio 50:1, split flow 75mL/min.ms zones set at MS Source 230^{0}C and MS Quad 150^{o}C .The oven temperature programme was 35^{o}C for 5mins, then4^{o} C/min to 150^{o}C for 2mins,then 20^{o}C/ mins to 250^{o}C for 5mins. Data processing was performed using the NIST library to identify the resulting peaks. The peaks of different fatty acids are shown in Figures 1-14.

3.0 Statistical analyses

For all experiments conducted, one way Analysis of variance (ANOVA) was carried out and the significant differences of means were calculated using Statistical Analysis System (SAS, 8.1). Results were expressed as means ± Standard Deviation (SD). A probability value at $p< 0.05$ was considered to denote the statistically significant differences.

4.0 Results and Discussion

Table 2: Variations on specific gravity value, pH value and refractive index value in some members of Cucurbitaceae.

Taxa	Specific gravity (g/cm^3)	pH value	Viscosity (cSt)	Refractive index at 25^{o}c
Citrullus lanatus	*0.87±0.01*^{a}	6.12±0.12^{i}	35.25±1.91^{d}	1.46±0.01^{cde}
Cucumis sativa	*0.91±0.01*^{b}	6.80±0.01^{l}	24.38±2.33^{a}	1.48±0.01^{g}
Cucumis melo	*0.91±0.01*^{b}	6.05±0.01^{h}	26.75±1.91^{b}	1.48±0.01^{efg}
Adenopus breviflorus	*0.94±0.01*^{c}	5.02±0.01^{a}	39.38±1.85^{f}	1.48±0.01^{g}
Trichosanthes auguina	*0.90±0.01*^{b}	6.55±0.01^{k}	36.50±3.02^{de}	1.48±0.01^{fg}
Cucumeropsis manni	*0.91±0.01*^{b}	6.30±0.01^{j}	31.00±1.41^{c}	1.48±cde^{fg}
Luffa cylindrica	*0.91±0.01*^{b}	5.56±0.04^{f}	30.13±1.25^{c}	0.75±0.01^{b}
Cucurbita pepo	*0.91±0.01*^{b}	5.63±0.01^{g}	35.88±2.80^{d}	0.72±0.01^{a}
Telfaria occidentalis	*0.91±0.01*^{b}	5.20±0.01^{b}	36.75±1.58^{de}	1.46±0.01^{d}
Momordica charantia	*0.97±0.01*^{b}	5.56±0.01^{f}	34.50±1.51^{d}	1.47±0.01^{defg}
Lagenaria siceraria (Oblong fruit)	*0.90±0.01*^{b}	5.26±0.01^{c}	39.88±1.25^{f}	1.47±0.01^{cdefg}
Lagenaria siceraria (flask-shaped fruit)	*0.91±0.01*^{b}	5.34±0.02^{e}	38.63±0.92e^{f}	1.46±0.02^{c}
Lagenaria siceraria (small round)	*0.96±0.01*^{d}	5.27±0.02^{c}	40.38±0.92^{f}	1.46±0.02^{cd}
Lagenaria siceraria (spherical fruit)	*0.91±0.01*^{b}	5.31±0.01^{d}	39.63±1.19^{f}	1.46±0.02^{cdef}

*Values with same superscripts are not significantly different while the ones with different superscripts are significantly different, at P value ≤ 0.05.

Table 3: variations on acid value, saponification value and iodine value in some members of cucurbitaceae.

Taxa	Saponification Value (mgKOH/g)	Acid Value (mgKOH/g)	Iodine value (mgKOH/g)	Peroxide value (mg/g)
Citrullus lanatus	115.92±0.01^{c}	8.96±0.01^{k}	54.41±0.01^{d}	18.74±0.01^{l}
Cucumis sativa	186.01±0.01^{h}	5.01±0.01^{g}	123.02±0.02^{l}	7.01±0.01^{i}
Cucumis melo	193.01±0.01^{i}	6.05±0.01^{i}	10.45±0.01^{b}	8.01±0.01^{j}
Adenopus breviflorus	211.52±0.01^{l}	2.51±0.01^{d}	110.03±0.01^{f}	5.01±0.01^{d}
Trichosanthes auguina	185.01±0.01^{g}	8.40±0.01^{j}	126.40±0.01^{m}	2.20±0.10^{b}
Cucumeropsis manni	204.18±0.01^{k}	5.48±0.01^{h}	112.77±0.01^{h}	9.01±0.08^{k}
Luffa cylindrica	66.81±0.01^{b}	2.63±0.01^{f}	0.62±0.01^{a}	9.01±0.01^{k}
Cucurbita pepo	160.62±0.01^{e}	35.11±0.01^{l}	121.35±0.01^{k}	5.65±0.01^{f}
Telfairia occidentalis	178.01±0.01^{f}	1.21±0.03^{a}	110.02±0.02^{e}	1.26±0.10^{a}
Momordica charantia	202.11±0.01^{j}	2.24±0.01^{c}	118.52±0.01^{i}	6.70±0.10^{h}
Lagenaria siceraria (Oblong fruit)	202.12±0.02^{j}	2.60±0.02^{e}	39.04±0.03^{c}	3.54±0.02^{c}
Lagenaria siceraria (flask-shaped fruit)	22.08±0.05^{a}	2.25±0.01^{c}	120.04±0.03^{j}	6.10±0.01^{g}
Lagenaria siceraria (small round)	160.04±0.03^{d}	2.62±0.01^{f}	112.03±0.03^{g}	2.21±0.01^{b}
Lagenaria siceraria (spherical fruit)	66.77±0.10^{b}	1.23±0.02^{b}	110.02±0.02^{e}	5.62±0.03^{e}

Value carrying same superscripts are not significantly different while the one carrying different superscrips are significantly different, at P value ≤ 0.05

The value of specific gravity observed from the studied samples is close to the standard range for biodiesel (Ejikeme *et al.,* 2008) (Table 2) *Citrullus lanatus* has the least specific gravity while *Momordica charantia* has the highest (Table 2). The specific gravity of oil indicates that it is less dense than water and therefore would be useful in cream production as it will make the oils flow and spread easily on the skin (Oyeleke *et al.,* 2012). According to Yahaya *et. al* (2012) specific gravity is commonly used in conjunction with other properties in assessing the purity of oil. However the specific gravity of oil does not have a significant effect on its use as a raw material in alkyl resin preparation though it is helpful in the determination of the weight which is useful for the purpose of bulk transportation (Kirt-othmer,

1967). The pH values of all the seed oils were acidic (Table 1). Refractive index of an oil is the ratio of speed of light at a defined wavelength to its speed in the oil/fat itself. This value varies with wavelength and temperature, the degree and type of unsaturation, the type of substitutions of component fatty acids and with accompanying substances. Most of the seed oils studied have their refractive index values within the acceptable range of 1.46 to 1.48 for virgin, refined and refined-pomace oils according to Codex Standards for fats and oils from vegetable/plant sources (CODEX-STAN, 1999). Also in agreement with the value reported (1.46) for *Blighia sapida* oil (Akintayo and Bayer, 2002). (Table 1). Refractive index is widely used in quality control to check for the purity of materials and to follow hydrogenation and isomerization (Hoffman, 1986). The specific gravity and refractive index measures the purity of the oil .The results from this work indicates that the oils are of high purity. Viscosity values of the samples studied is similar with the work reported by Oyekunle *et al.,* (2007) Table 1, which can be used for driving stationary engines as being practiced in Mali. The more viscous oil is, the better its use as lubricant (Belewu *et al.,* 2010). The oil could be used as lubricant in engine parts in the tropics if left overnight as solidification temperature of the oil is below -100ºC at any season (Oyekunle *et al.*, 2007). The specific gravity and viscosity values of the oil were compared with those obtained for Glycine max (soy bean) as reported by Akanni *et al.* (2005). Hence, they can be used as water evaporation retardants in arid regions where acute shortage is a menace. Also, since the oil is prone to faster biodegradation than fossil fuels, there is no problem of long term environmental pollution that may arise from their use. It may also be useful for short term application in preservation of water for molding blocks and watering seedlings.

The saponification value of most of the seed oils studied is high and this suggests the use of the oils in production of liquid soap, shampoos and lather shaving creams. The low saponification value as found in *Lagenaria siceraria* (spherical shaped), *Lagenaria siceraria* (flask shaped) and *Luffa cylindrica* indicated that the oils of these seeds may not be suitable for soap making. (Table 2). Saponification value is a measure of oxidation during storage, and also indicates deterioration of the oils. An increase in saponification value in oil increases the volatility of the oils. It enhances the quality of the oil because it shows the presence of lower molecular weight components in 1 g of the oil which will yield more energy on combustion (Engler and Johnson, 1983). The low saponification value is an indication that the oil may not be suitable for soap making, oil-based ice-cream and shampoos. The saponification value in most of the studied seed oils were similar to the values obtained for some vegetable oils ranging from 188-196mgKOH/g (Pearson, 2006). However, there are some vegetables with higher saponification values such as coconut oil (253mgKOH/g), palm kernel oil (247mgKOH/g) and butter fat 225(mgKOH/g). It has been reported by (Mestrallet *et al.*,2004) that oils with higher saponification values contain high proportion of lower fatty acids. The acid value of some of the seed oils studied were relatively low compared to that reported for tropical almond and some were similar to that of Fluted pumpkin (Christian, 2006) and some also similar to what Esuoso *et al.* (1998) reported for Fluted pumpkin seed oil. (Table 2). This is also in agreement with the limit recommended for virgin edible oils by Codex Standards. This can be used to check the level of oxidative deterioration of the oil by enzymatic or chemical oxidation. Acid value gives an indication of the quality of fatty acids in oil. Low acid value in oil indicates that the oil will be stable over a long period of time and protect against rancidity and peroxidation. This could be attributed to presence of natural antioxidants in the seeds such as vitamins C and A as well as other possible Phytochemical like flavonoids. Acid value is used as an indicator for edibility of an oil and suitability for use in the paint and soap industries (Aremu *et al.,* 2006). High acid value in oil showed that the oil may not be suitable for use in cooking, but however, be useful for production of paints, liquid soap and shampoos (Akintayo, 1997; Aremu *et al.,* 2006). Also appreciable acid value of oils is an indication that the plant might be poisonous for livestock (Aremu *et al.,* 2006). The acid value is expected to range from 0.00-3.00mgKOH/g oil before it can find application in cooking (Oderinde *et al.,* 2009) and the values of some of the oils studied fall within this range while some were higher than 3.00mgKOH/g but they can be made fit by subjecting the oil to refining and this may also improve its quality for industrial purposes. The iodine value of the sample studied is similar to that of peanut, cotton seed, sesame and sun flower (Aremu *et al.,* 2006). (Table 2). Thus, most of the oils studied may not be suitable as Alkyl resins for paint formulation or use as Varnisher since they cannot be grouped as drying oil because of their iodine values. The iodine value is a measure of the degree of unsaturation and it is an identity characteristic of seed oils, making it an excellent raw materials for soaps cosmetics industries (Akintayo, 2009). The iodine value could be used to quantify the amount of double bond present in the oil which reflects the susceptibility of the oil to oxidation. Aremu *et al.*

(2006) reported that the lower the iodine value the lesser the number of unsaturated bonds; thus the lower the susceptibility of such oil to oxidative rancidity. This implies that the oil cannot be preserved for a long period of time. Oils with iodine value above 130 are classified as drying oils; those with iodine value 100–130 are classified as semidrying oils. Those with iodine value less than 100 are considered as nondrying oil (Cocks and Van Rede, 1996). Therefore, non-drying oils are not suitable for ink and paint production due to their non-drying characteristics but may be useful in the manufacture of soaps (Kochar, 1998) and can be regarded as liquid oil. A good drying oil should have iodine value of 130 and above. High iodine value is a pointer to the presence of high percentage of unsaturated fatty acids in the seed oil; as such amount of iodine that will be absorbed by the unsaturated acids would be higher (Eze, 2012) and oils with such characteristic may therefore be found useful as raw materials in the manufacture of vegetable oil-based ice cream (Oderinde *et al.*, 2009). All the oils are semi drying oils except *Luffa cylidrica, Citrullus lanatus* and *Lagenaria siceraria* (Oblong shaped) oil which are non drying oils and can be used in paint industry. The iodine value of *Cucumeropsis manni* was 112.03, a value slightly lower comparable to what has been reported in other studies (Badifu, 1991; Milovanovic and Picuric-Jovanovic, 2005). The difference may be due to geographical location, soil condition and climatic factors. The peroxide values obtained in this study is lower than 15mg equivalent oxygen Kg-1 that was obtained in virgin oil (Aremu *et al*., 2006) and lower than the Codex standard value (10 Meq/kg) for refined vegetable oil. It is also lower than the maximum value (20 Meq/kg) allowed for unrefined olive oil (FAO/WHO, 1993) except *Citrullus lanatus* which is 18.74 mg equivalent oxygen Kg-1 and it is similar to the value obtained by Edidiong and Ubong, (2013) for *Citrullus lanatus* (20.00 mg equivalent oxygen Kg-1). The lower the peroxide value, the better the quality of the oil. The low peroxide values of the oils indicate that they are less liable to oxidative rancidity at room temperature (Odoemelam, 2005 and Anyasor *et. al.*, 2009). The high peroxide value shows that the oil can easily go rancid and therefore has short shelf life. Oils having high percentages of peroxide are unstable and grow rancid easily (Nzikou *et al.*, 2007). Fresh seed oils often exhibit peroxide value less than 10 mequiv. O2/kg oil (Anon., 1999) while 20-40 mequiv. O2/kg oil means the oil is rancid (Adelaja, 2006).

5.0 Conclusion

From this study, seed oils of some members of *Cucurbitaceae* have significantly showed the taxonomic relationship of members of this family. Despite the fact that the fourteen samples belong to the same family of *Cucurbitaceae,* the physicochemical analysis showed differences in their seeds oils. The results of the fourteen samples studied have further provided guidance for taxonomic delimination of the family *Cucurbitaceae*. Hence seed-oils can be used in classification of the family '*Cucurbitaceae'.*

6.0 References

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