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Physicochemical Characteristics and the Effect of Packaging Materials on the Storage Stability of Selected Cucurbits Oils

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Abstract Physicochemical properties and the effect of packaging materials on the quality of oil extracted from *Cucumeropsis manni, Lagenaria sicceraria* and *Citrullus lanatus* were studied in this work. Oil was extracted from *Lagenaria sicceraria* (bottle gourd), *Cucumeropsis manni* (white melon) *and Citrullus lanatus* (watermelon) seeds, some physicochemical attributes of the oil extracted were determined. The three samples of oil were stored in amber glass bottle, transparent glass bottle and transparent plastic bottle at ambient temperature for 12 weeks during which stability of the oil to oxidative and hydrolytic deterioration was assessed by determining peroxide value and free fatty acid value at 2weeks interval. The results show that the physicochemical characteristics of oil samples extracted from *Lagenaria sicceraria, Cucumeropsis manni and Citrullus lanatus* seeds were: specific gravity 0.89, 0.90, 0.87; refractive index 1.517, 1.520, 1.518; iodine number 97.16 mgI_2/g, 101.52 mgI_2/g, 98.26 mgI_2/g; saponification value 215.99 mgKOH/g, 221.60 mgKOH/g, 183.73 mgKOH/g; thiobabituric acid number 4.45 mgMA/Kg, 2.03 mgMA/Kg, 2.19 mgMA/Kg; free fatty acid value 18.80%, 0.57%, 5.31% and peroxide value 0.02 Meq/kg, 0.14 Meq/kg, 0.09 Meq/kg respectively. The result of storage stability shows that the oil samples may be relatively stable to oxidation and hydrolysis when properly stored in a good packaging material. Oil samples stored in plastic transparent bottle recorded highest lipid peroxidation values while amber glass bottle gave the maximum protection against lipid peroxidation.

Keywords: *cucurbitaceae, oil, physiochemical characteristics, storage stability*

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1. Introduction

Cucurbitaceae (Cucurbits) is an important versatile family comprising hundreds of species of vine bearing coiled climbing tendrils [11]; some important cucurbit family members which include *Lagenaria siceraria* (bottle gourd), *Colocynthis citrullus* (melon) *Cucumeropsis mannii* (white melon), *Cucurbita maxima* (pumpkin), *Cucurbita moschata* (musk melon), *Cucumis sativa* (Ibo egusi) and *Citrullus lanatus* (water melon), *Cucumeropsis manni* (white melon) and *Lagenaria sicceraria* (bottle gourd) are tropical African plants which have fruits of different sizes ranging from as small as cricket ball to as big as basketball. They are widely available in the South – Eastern part of Nigeria.

Previous studies showed that the seeds contain good amounts of oil that can be exploited [7,8] and the oil contain mostly four main fatty acids: palmitic, stearic, oleic and linoleic acid [13]. *Citrullus lanatus* (water melon) fruit plays a very important role in Africa as it is used to quench thirst during shortage of water; its seeds have been prized for the highly nutritive oil they contain which is rich in essential fatty acids. Some of the major oils usually consumed in Nigeria are palm oil, groundnut oil, coconut oil, soy beans oil but due to increase in demand for oil, effort has been made towards the extraction of oil from different sources which include *Cucurbita maxima* oil, *Cucumeropsis manni* oil and *Citrullus lanatus* oil to mention a few. Edible oils have been recognized as the most common valuable food ingredient and may contain significant level of essential fatty acids; they are sources of fat soluble vitamins such as vitamin E.

Lipid peroxidation is a major deteriorative change commonly encountered in oil and the extent of lipid peroxidation depends on different factors which include the fatty acid composition viz-a-viz level of unsaturation; packaging material and storage condition [15]. Among other functions, packaging serves to protect food materials against contamination and adverse environment conditions that can initiate deterioration of food material. Fat and oil are usually packaged in a material that will protect them against atmospheric oxygen, light, heat and metal contamination. These factors are known to accelerate lipid peroxidation and the development of rancidity in oil.

Glass, metals and different kinds of plastic bottles have been used to package oil, each with its advantages and limitations. A lot has been done on oils extracted from *Cucumeropsis manni* and *Lagenaria sicceraria* however, literature survey revealed dearth of information on the physicochemical characteristics of oil extracted from *Citrullus lanatus* and the comparative evaluation of the physicochemical characteristics of these Cucurbitaceae oils, likewise the storage stability of these Cucurbitaceae oils with respect to packaging materials has not been evaluated. This work is aimed at evaluating some physicochemical properties and the effect of packaging materials on the quality of oils extracted from *Cucumeropsis manni, Lagenaria sicceraria* and *Citrullus lanatus.*

2. Materials & Methods

2.1. Sample Treatment & Oil Extraction

The Unshelled seeds of *Lagenaria sicceraria* (bottle gourd), *Cucumeropsis mann*ii (white melon) and the fruit of *Citrullus lanatus* (water melon) were purchased from Central market in Ado-Ekiti, Ekiti State, Nigeria. *Citrullus lanatus* (water melon) seeds were removed from water melon fruit after which the seeds were dried in the sun to facilitate shelling. The seeds were shelled manually and dried in a hot air oven at 50^{o}C before grinding into fine powder in order to facilitate oil extraction. The samples were packaged in polythene bags, sealed, labeled appropriately and stored in an air tight plastic container for further use. Oil was separately extracted from the three seed flour samples by continuous reflux in a soxhlet extraction apparatus for 6 hrs with n-hexane as the solvent. The percentage oil recovered was determined.

2.2. Physicochemical Analysis

The oil samples were analyzed for refractive index, specific gravity, iodine number, saponification value, Thiobabituric acid number, peroxide value and free fatty acid value using standard procedures described by AOAC (2005).

2.3. Storage Study

The three oil samples were stored in amber glass bottle, transparent glass bottle and transparent plastic bottle at ambient temperature for 12 weeks. Peroxide value and free fatty acid value of the oil samples were determined at two weeks interval in order to assess the stability of the oil towards deteriorative changes.

2.4. Statistical Analysis

Analytical determinations were done in triplicates and data generated were subjected to Analysis of Variance (ANOVA) using SPSS 17.0 computer programme.

3. Results & Discussion

3.1. Physicochemical Characteristics

The results of the physicochemical characteristics of oil samples extracted from *Lagenaria sicceraria* (LS), *Cucumeropsis mannii* (CM) and *Citrullus lanatus* (CL), are given on Table 1.

Table 1. Physicochemical Characteristics of Oil Extracted From *Lagenaria sicceraria* (LS) *Cucumeropsis manni*(CM) and *Citrullus lanatus* (CL)

Physicochemical Characteristics	LS	CM	CL
Percentage oil recovered (%)	22.60 ± 1.20^{b}	40.10 ± 2.00^{a}	36.50 ± 2.50^{a}
Specific gravity	0.89 ± 0.02^{a}	0.90 ± 0.01^{a}	0.87 ± 0.01^{a}
Refractive index	1.517 ± 0.100^{a}	1.520 ± 0.120^{a}	1.518 ± 0.100^{a}
Iodine value (mgI$_2$/g)	97.16 ± 1.50^{b}	101.52 ± 1.00^{a}	98.26 ± 1.00^{b}
Saponification value (mg KOH/g)	215.99 ± 3.00^{a}	221.60 ± 3.00^{a}	183.73 ± 3.10^{b}
Thiobabituric Acid No. (mgMA/kg)	4.45 ± 0.20^{a}	2.03 ± 0.20^{b}	2.19 ± 0.10^{b}
Free Fatty Acid value (%)	18.80 ± 1.20^{a}	0.57 ± 0.10^{c}	5.31 ± 0.50^{b}
Peroxide value (Meq/kg)	0.02 ± 0.01^{c}	0.14 ± 0.01^{a}	0.09 ± 0.01^{b}

Data represent means of three determinations ± standard deviation
Values with different superscript on the same row are significantly different ($P \leq 0.05$).

The percentage oil recovered of *Lagenaria siceraria* (LS) was the lowest while that of *Cucumeropsis mannii (*CM*)* was the highest. The 40.10% oil recovered from CM was lower than 44.85% reported by [8], the 36.50% oil recovered from *Citrullus lanatus (*CL*)* indicates that watermelon can be a good source of oil however this figure was lower than 43.32% reported by [14]. Fokou *et al* (2009) had reported that the oil contents of seeds of species of cucurbitaceae depend on the areas of cultivation. There was no significant difference in the refractive index and specific gravity of the three oil samples, the specific gravity was in the range of 0.87 for *Citrullus lanatus* oil to 0.90 for *Cucumeropsis mannii* oil. The specific gravity of CL oil compared well to that obtained by [14] while that reported for LS oil in this work was higher that what was obtained by [3].

The Free fatty acid (FFA) values of the three oil samples which ranged from 0.57% to 18.8% were significantly different; the free fatty acid value of CM oil was lower than 4.5% reported by [6]. The free fatty acid value of oil sample extracted from LS was significantly higher than those extracted from other seeds. The high value of free fatty acid in LS oil may be as a result of the method of processing the oilseed. Some of the seeds, once extracted from the fruits were left overnight to slightly ferment while some farmers allow the fruits to get rotten before the seed are extracted from the fruit in order to reduce the sticky and slimy nature of the pulp of the fruits for easy washing of the seeds. Fermentation favours the actions of lipolytic enzymes which hydrolyse the triglyceride in the seeds, liberating free fatty acids. Also the conditions and duration of storage of the seeds may affect the free fatty acid value [8].

The Saponification values of the oil samples were high and were 221.60 mgKOH/g (CM), 215.99 mgKOH/g (LS) and 183.73 mgKOH/g (CL). The saponification value reported for CL oil in this work was higher than 175.98 mgKOH/g reported by [5a] for CL oil. Saponification value has implication in the industrial use of oil especially for soap production and it is also a reasonable means of characterizing oil. The results also show that the three oil samples had a relatively mild degree of unsaturation; Iodine numbers of the three oil samples were 97.16 mgI_2/g (LS), 98.26 mgI_2/g (CL) and 101.52 mgI_2/g (CM). The iodine number of CM oil was much lower than 114.94 mgI_2/g reported by [6], while the iodine numbers of LS oil and CL oil samples were higher than 87.24 mgI_2/g reported by [5b] for groundnut oil. Iodine number which indicates the level of unsaturation in oil is one of the chemical characteristics usually used to established identity. The higher the iodine number the higher the level of unsaturated fatty acid (degree of unsaturation) in the oil. Oil with unsaturated fatty acids is easily assimilated and broken down to produce calorific energy than oil with saturated fatty acids however when the level of unsaturation becomes high as indicated by high iodine number, the stability of the oil reduces because unsaturated fatty acids are highly susceptible to oxidation. Oil extracted from CM which had the highest iodine number and invariably higher level of unsaturation may be an indication that it will be susceptible to oxidative rancidity than the other oil samples.

The peroxide value which is usually used as an indication of deterioration of oil measures the primary oxidative products (peroxides and hydroperoxide) of fat and oil. The peroxide values of the oil samples were relatively low however, the peroxide value of oil extracted from CM was the highest amidst the three oil samples. These oils contain mostly polyunsaturated fatty acids which can easily undergo oxidation with likely increase in peroxide content especially when the oils are not properly packaged and stored. Generally peroxide value of oil samples may be influenced by much exposure of the seeds to the sun during drying causing lipid oxidation resulting from the absorption of oxygen which increases the formation of peroxide [2]. The peroxide value of the three oil samples were lower than 3.07 Meq/kg and 9.65 Meq/kg reported by [5b] for palm oil and groundnut oil respectively. The low peroxide values of the three oil samples give an indication that they have good storage potential. Thiobabituric acid (TBA) number measures carbonyl compounds especially malondialdehyde which is a secondary product of lipid oxidation. The thiobabituric acid number of LS oil was the highest and it was significantly different from that of other oil samples analyzed in this work.

3.2. Storage Stability

Figure 1 and Figure 2 show the graph of peroxide value and free fatty acid value of oils extracted from *Cucumeropsis manni*, *Lagenaria sicceraria* and *Citrullus lanatus* stored in three different packaging materials over 12 weeks respectively.

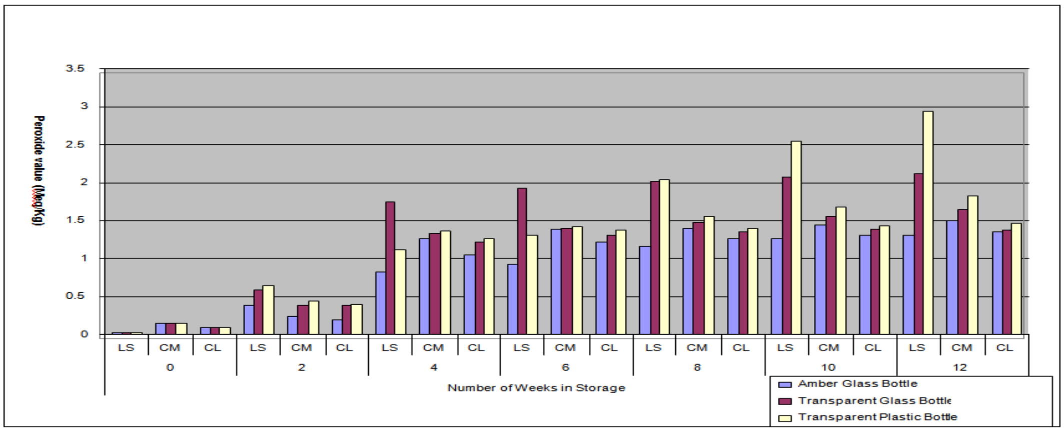

Figure 1. Peroxide Values (Meq/kg) of Oil Extracted From *Lagenaria sicceraria (LS)*, *Cucumeropsis manni(CM) and Citrullus lanatus (CL)* Stored in Different Packaging Materials

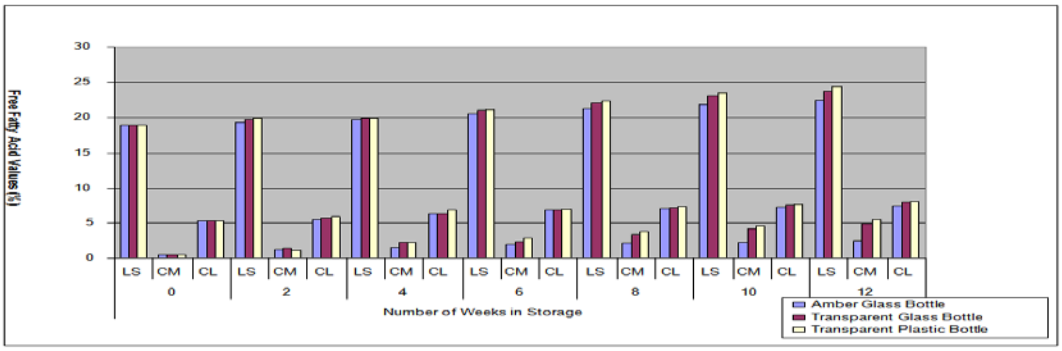

Figure 2. Free Fatty Acid Values (%) of Oil Extracted From *Lagenaria sicceraria (LS)*, *Cucumeropsis manni(CM) and Citrullus lanatus (CL)* Stored in Different Packaging Materials

Figure 1 shows the peroxide values (PV) of the three oil samples during the 12 week of storage under ambient condition. As expected light usually has an adverse effect on the stability of oil in terms of the acceleration of oxidative rancidity as evident by increase in peroxide value. There was a gradual increase in the peroxide value during storage and this was due to the oxidation of unsaturated fatty acid in the three oil samples. It is known that oxygen and light can accelerate the oxidation of unsaturated fatty acid to form peroxide and that transparent packaging materials will allow easy refraction of light rays.

Generally, for all the oil samples the amber glass bottle gave the best protection against deteriorative oxidative changes in the oil samples as indicated by the low peroxide and free fatty acid values. This pattern of result is consistent with what was reported by [9,10,12]. On the last week of storage, LS oil stored in amber glass bottle recorded the lowest peroxide value of 1.31 Meq/kg while LS oil stored in transparent plastic bottle recorded the highest peroxide value of 2.94 Meq/kg. The peroxide values of the three oil samples stored in transparent plastic bottle were the highest on the last week of storage and its range during storage was 0.02 -2.94 Meq/kg (LS), 0.14-1.82 Meq/kg (CM) and 0.09-1.47 Meq/kg (CL). The free fatty acid value measures the level of free fatty acids in oil, which can be used as a measure of its quality. It is well accepted that during storage partial hydrolysis of oils takes place thus increasing free fatty acid content, the extent of this hydrolysis depends on the packaging material and storage condition. In refined vegetable oil, the lower the free fatty acid content the more stable the oil and the more acceptable the oil to the human palate [4]. The pattern of the result on free fatty acid values of the three oil samples which is an indicator of hydrolytic changes during the 12 week of storage was similar to that of the peroxide value. The range of the free fatty acid values during the 12 week of storage was 18.80% – 24.40% (LS), 0.57% - 5.49% (CM) and 5.31% - 8.12% (CL). In term of percentage increase in the free fatty acid value during the storage period, LS oil had the lowest percentage increase while CM had the highest percentage increase.

4. Conclusion

This work confirmed the three species of *Cucurbitaceae* studied to be good sources of oil with physicochemical properties similar to that of known edible oil. Oil extracted from *Lagenaria sicceraria* (LS) has exceptionally high free fatty acid. Generally amber glass bottle offered the best protection against lipid peroxidation and hydrolysis of triglycerides. Further work can be done on the effect of storage condition on the storage stability of these *Cucurbitaceae* oil.

Statement of Competing Interests

The authors have no competing interests.

References

[1] AOAC: Association of Official Analytical Chemist, *Official Method of Analysis*. 18th edition, Washington 2005.

[2] Cheftel J. C. and Cheftel H.: Introduction a la Biochimie et a la Technologie des Aliments. Technique et documentation 243-330. 1992 Paris Cedex 1.1992.

[3] Chinyere C. G., Emmanuel I. A., Nwaukwa I. C. and Ugbogu A. E: Nutritive Value of *Lagenaria sphaerica* seed (wild bottle gourd) from south-eastern Nigeria. Pakistan Journal of Nutrition 8(3) 284-287. 2009.

[4] Codex Alimentarius: Codex Alimentarius Standards for Fats and Oils from Vegetable Sources.Section 2. *Codex Alimentarius Standards for Named Vegetable oil*. Codex Alimentarius-Stan 210 1999.

[5] 5a. Ebuehi O. A. T. and Avwobobe O. K.:Physico-chemical and fatty acid composition of water melon (*Citrullus lanatus*) and melon (*Colocynthis citrullus*) seed oils.. *Nigerian Food Journal* 24 (1) 25 - 33. 2006.
5b. Ebuehi O. A. T, Umeh R. A and Oletu F. U.: Physico-chemical and fatty acid composition of two common edible vegetable oils in Nigeria. *Nigerian Food Journal* 24 (1) 17-24. 2006.

[6] Essien E. A., Umoren S. A., Essien E. E. and Udoh A. P.: Preparation and evaluation of Cucumeropsis mannii Naud seed oil metallic soaps as driers in gloss paint. *Journal of Material and Environmental Sciences*. 3(3). 477-484. 2012.

[7] Fokou E., Achu M. B. and Tchouanguep F. M.: Preliminary nutritional evaluation of five species of egusi seeds in Cameroon. *African Journal of Food, Agriculture,l Nutrition and Development* 4 (1). 1-11. 2004.

[8] Fokou E., Achu M. B., Kansci G., Ponka R., Tchiegang C. and Tchouanguep F. M.: Chemical composition of some cucurbitaceae oils from Cameroon. *Pakistan Journal of Nutrition* 8(9) 1325-1334.2009.

[9] Kucuk M and Caner C: Effect of packaging materials and storage conditions on sunflower oil quality. *Journal of Food Lipids* 12. 222-231. 2005.

[10] Nkpa N. N., Osanu F. C. and Arowolo T. A.: Effect of Packaging Materials on the Storage Stability of Crude Palm Oil. *Journal of American Oil Chemists' Society* 67 (4) 259-263.1990.

[11] Ogundele J. O. and Oshodi A. A.: Proximate composition and some functional properties of three varieties of *Lagenaria Siceraria*. *Research Journal of Agriculture and Biological Sciences* 6(2) 108-112.2010.

[12] Rababah T. M., Feng H., Yang W., Eriefej K and Al-Omoush M.: Effects of type of packaging material on the physicochemical and sensory properties of olive oil. International Journal of Agriculture and Biological Engineering 4 (4) 66-72. 2011.

[13] Silon T., D. Mamponya, W.D Loka lonyage, M. saadon: Composition Globale et Caracteristiques des huiles extraits de espeles de cacurbitaceae du Niger. La Rivista Italians Delle sostaze Grasses. LXXVI: 141-144. 1999.

[14] Taiwo A. A., Agbotoba M. O., Oyedepo J. A., Shobo O. A., Oluwadare I. and Olawumi M. O: Effects of drying methods on properties of water melon (Citrullus lanatus) seed oil. African Journal of Food, Agriculture, Nutrition and Development 8 (4). 492-501. 2008.

[15] Yu Liscanlen, L. Wilson J. And Schmielt: Rosemary Extracts as Inhibitors of liquid oxidation and colour changes in cooked Turkey products during Refrigeration. Food Science 62(2) 382-385. 2000.