Extraction and Characterization of Fluted Pumpkin (*Telfairia Occidentalis)* Seed Oil

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Abstract

This work examined the extraction and the characterization of Telfairia occidentalis seed oil. The seed was found to have moisture content of 8.29% on the average. The extraction of the seed oil was performed with petroleum ether on a dry matter basis, and the oil content found to be within 51-53%. The seed oil quality parameters were; specific gravity (SG), 0.90g/ml, iodine value (IV), 98.4g iodine/100g oil, saponification value (SV), 105.19meqKOH/kg oil acid value (AV), 11.78mg KOH/kg oil, free fatty acid (FFA), 5.92% of oil, peroxide value (PV), 40meq peroxide/kg oil, and kinematic viscosity, 21.21mm^2/s at 32°C. The characteristic properties of the oil compared well with those of local and sales seed oils.

Key words: *Fluted Pumpkin, Extraction Telfairia occidentalis Seed Oil (TOSO), Oil Characterization*

Introduction

Telfairia occidentalis is a member of Cucurbitaceae family, cotyledonous and a perennial plant with more than 80 genera and about 750 species distributed across the global warm parts (Odiaka, Akoroda & Odiaka, 2008). The crop originated probably in the south east of Nigeria and spread all over the country by Igbos who have been cultivating this crop for decades (Olaniyi & Oyerele 2012). The variety *Telfairia occidentalis* is the one mostly found, widely consumed and cultivated in Nigeria for its eatable leaves, succulent shoots and seeds as a terrace plant mainly by the Igbos. With the spread of Igbos in Nigeria, *Telfairia* is now grown in almost all the parts of Nigeria (Odiaka et al. 2008). It is a leafy green vegetable plant that climbs by its coiled tendrils and bifid. Its compound leaves, usually 3-6 foliate, have petioles and blades covered with multicellular hairs. The fruits are variable in size, colour, shape and weight, and possess 10 clearly visible longitudinal ridges and are among the largest known (15-55 cm length, 10 cm diameter). The seeds are large, non-endospermic and normally dark red in colour embedded within a bright-yellow fibrous endocarp (Olurunfemi, Munavvar, & Hassaan, 2014).

Kayode & Kayode (2011) reported that *Telfairia occidentalis* amino acid profile revealed that it is very rich in the nine essential amino acids (histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine) and some of the non-essential ones which includes, alanine, cystine, glutamine, glycine, serine, and tyrosine. *Telfairia* leaf has abundant minerals (such as iron, magnesium, phosphorus, potassium and sodium) antioxidants, vitamins (such as ascorbic acid, nicotinamide, riboflavin and thiamine) and phytochemicals like phenols. The leaves have high nutritive value when compared with other warm climate vegetables. It has higher protein content (22 %) than those of commonly consumed leafy vegetables. The leaves have abundant vitamins and minerals such as Calcium, iron, phosphorus etc and are also consumed as food (Olurunfemi et al. 2014; Odiaka et al. 2008). The seed oil obtained is useful for cooking.

Olurunfemi et al. (2014) reported that *Telfairia* plants possess important Antioxidant, Antidiabetic, Hematological, Anticanceral, Hepatoprotective, Antimicrobial, Biochemical, Anti-inflammatory and Analgesic properties. Kayode & Kayode (2011) reported that *Telfairia* seeds have high oil content, particularly unsaturated fatty acids that contain 62% of the oil. *Telfairia* seeds have high protein content of (>26%) and extractable oil (50-60%). Its oil serves as a breast massage to enhance milk flow and promotes hair lustre and growth. The oil equally softens and supple skin. (Ajayi, Dulloo, Vodouhe, Berjak, & Kioko, 2007). Odiaka et al. (2008) says that *Telfairia* seeds nutritional value (about 52% fat and 28% crude protein) justifies the wide consumption by possession of excellent quantity of amino acids (almost 94%) containing greater percentage of the essential amino acids (except lysine), and higher content of K and Na available (almost 59%). The higher oil yield of *Telfairia* seeds have made them good raw materials for the vegetable oil and margarine companies in Nigeria.

Despite its abundance in south eastern part of the country, its richness in seed oil and crude protein and the fact that the plant has the potentiality to become a good source of essential vitamins and minerals. There are limited studies on this plant, particularly in Nigeria. As such, this work is therefore focused at carrying out the extraction and the characterization of the seed oil of this plant.

Materials and Methods

Samples collection and identification: The *Telfairia* pulps were collected from an Igbo woman at Muda-Lawan Market, behind Bayan Gari Area of Bauchi town. The seeds were then perfectly identified at the Biological Sciences programme of Abubakar Tafawa

Balewa University Bauchi by Dr. Ahmad Abdulhamid.

The pulps were broken and the seeds removed, cleaned, air-dried at room temperature, cracked and peeled manually to remove the endocarp. The endocarps were then grounded and prepared for oil extraction.

Determination of moisture content of the seeds: Small portion (3g) of the grounded *Telfairia* seed prepared was placed in a dried and weighed crucible for oil extraction. The crucible containing the sample was put into a griffin adjustable temperature oven at 105°C, heating and weighing at 45 minutes intervals was done until a constant weight of the sample was obtained. The crucible was then cooled, and the moisture content determined with the formula seen below:

$$\text{Moisture percentage} = \frac{\text{Decrease in the sample weight}}{\text{Original weight of the sample}} \times 100\%$$

Seed oil extraction: The grounded *Telfairia* seed sample (68.7g) in a thimble was loaded into a Soxhlet extractor together with petroleum ether and the extraction conducted for 9 hours until it was ascertained that 95% of the oil have been extracted. The oil was then filtered to remove impurities present and a rotary evaporator was used to evaporate all the residual present in the oil. The weight of the oil was taken and the oil yield percentage calculated on a dry matter basis as seen below:

$$\text{Oil yield percentage} = \frac{\text{Weight of the oil}}{\text{Weight of the sample on dry matter basis}} \times 100\%$$

Oil Characterization

Physical Properties of the Oil.

Colour, smell and texture: The colour of the oil is light-yellow, its smell is pleasant and its texture is viscous.

Specific gravity: The method used is an improvised one for this property (Abayeh, Onuoha & Ugah, 2007). A cleaned improvised specific gravity bottle, rinsed with acetone, and dried in an oven. The bottle was cooled in a desiccator at room temperature and the weight of the empty bottle determined with an electronic balance. The weight of the bottle filled with water was taken. The water was then poured out, rinsed with acetone and dried in the oven. The same procedure was repeated with the TOSO and the specific gravity computed as follows:

$$\text{Specific gravity} = \frac{\text{Weight of oil}}{\text{Weight of equal volume of water}}$$

Chemical Properties of Oil

Free fatty acid (FFA): The method used for the determination was that of British standards institute No. 684 method was used for the determination of FFA (Association of Official Analytical Chemists, (AOAC, 1975).

Small portion (4g) of the TOSO was warmed in a 250ml conical flask. 25ml of methanol was added with thorough stirring, and 2 drops of phenolphthalein indicator was added. 0.14M NaOH solution was then titrated against the contents of the flask until a light pink colour which persisted for 1 minute was seen. The end point was taken and used to compute the FFA as seen below:

$$\text{FFA (as oleic)} = \frac{\text{Titre} \times M \times 28.2}{\text{Weight of the sample}}$$

Where;

M = Molarity of the base

Acid value: The method used for the determination was that of British standards institute No. 684 method was used for the determination of FFA (Association of Official Analytical Chemists, (AOAC, 1975).

Small portion (4g) of the TOSO was warmed in a 250ml conical flask. 25ml of methanol was added with thorough stirring, and 2 drops of phenolphthalein indicator was added. 0.14M NaOH solution was then titrated against the contents of the flask until a light pink colour which persisted for 1 minute was seen. The end point was taken and used to compute the FFA as seen below:

Acid value = % FFA (as oleic) x 1.99

Peroxide value (PV): The method used for the determination was that of British standards institute No. 684 method was used for the determination of FFA (Association of Official Analytical Chemists, (AOAC, 1975).

Small portion (2g) of the TOSO was put in a 250ml conical flask and 40ml chloroform/glacial acetic acid (2:3 v/v) was added. The contents were shaken until they dissolved. 1ml of saturated KI solution was added followed by 3 drops of 0.5ml starch indicator. This was then titrated with 0.1N $Na_2S_2O_3$ until the dark blue colour disappeared. Blank determination was also carried out and the peroxide value computed as seen below:

Peroxide value (meq/kg oil) = $\frac{(S-B)\times N\times 1000}{W}$

Where;
S = titre value of sample
B = titre value of blank
N = normality of sodium thiosulphate solution
W = weight of oil sample

Saponification value (SV): The method used for the determination was that of British standards institute No. 684 method was used for the determination of FFA (Association of Official Analytical Chemists, (AOAC, 1975).
Small portion (2g) of the oil was put into a 250ml conical flask and 25ml of 0.5M ethanol KOH solution was added. A reflux condenser was attached and the flask content refluxed for 40 minutes on a water bath while swirling until it simmered. The mixture was then titrated against 0.5M HCl using phenolphthalein indicator while still hot. A blank determination was then carried out under the same conditions and the saponification value calculated as seen below:

Saponification value = $\frac{(B-S)\times 28.05}{W}$

Where:
B = titre value of blank
S = titre value of sample
W = weight of oil

Iodine value (IV): The method used for the determination was that of British standards institute No. 684 method was used for the determination of FFA (Association of Official Analytical Chemists, (AOAC, 1975).
`Small portion (2g) of the TOSO was put in a 250ml conical flask followed by 40ml Hanus solution and the flask stoppered. The contents were mixed and placed in the drawer for exactly 30mins. It was then titrated against 0.1N $Na_2S_2O_3$ until the solution became light yellow. 2ml of 1% starch indicator was added and the titration continued until the blue colour just disappeared. A blank determination was also carried out under the same conditions and the iodine va;ue computed as thus:

Iodine value = $\frac{(B-S)\times N\times 12.69}{W}$

Where;
B= blank titre
S= oil sample titre
N= normality of $Na_2S_2O_3$
W= weight of oil

Results and Discussions

The table below showed the results obtained in this research.

Table 1: The results of the oil properties of TOSO

Parameters	***Telfairia occidentalis* seed oil (TOSO)**
Moisture %	8.29
Oil yield %	52.50
Colour	Light-yellow
Smell	Pleasant
Specific gravity g/ml	0.90
Viscosity mm^2/s	21.21 @ 30°C,
Peroxide value meq/kg	40
Acid Value mgKOH/g oil	11.78
Iodine value g/100g	98.40
Saponification value meq/kg	105.19
Free fatty acid %	5.92

The TOSO moisture content percentage (**Table 1**) shows that the *Telfairia* seed could be preserved for a long period without being damaged. This is a crucial oil quality parameter as it says that an oil seed is capable of being stored longer. This is as a result that seeds of high moistures are likely to be affected by enzymatic reactions which successively affect other properties of the oil including peroxide value, free fatty acid and acid value which are also important in judging the oil quality.

The oil yield (**Table 1**) is quite high implying that the seed oil could be exploited economically. This yield also compares appreciably with those oil yields reported for other commercial vegetable oils including groundnut (49.0%), cotton seed (19.05%), palm oil (48.65%) and soybean (19.0%) (Dawodu, 2009).

The specific gravity of oil as the ratio of the mass of a given volume of oil to the mass of an equal volume of water, is related to the fatty acid content of the oils and their average molecular weights. The value obtained in this work (**Table 1**) indicates that the oil can be used in the production of lubricants and for other uses such as production of biodiesel.

Acid value is an index for the eatability of an oil and applicability for use in industry. It is the measure of the extent to which the triglycerides in the oil have been decomposed by lipase or other reactions. It therefore stands as a key indicator of the realness of oil. Values of 0.6 and 10mgKOH/g oil are recommended for mechanically and chemically produced consumable fats and oils respectively (Adelaja, 2006). The value obtained for TOSO in this work (**Table 1**) is quite okay implying that the oil is good for eatable purposes and in the production of varnishes and paints (William, 1966).

Peroxide value is the measure of peroxides contained in the oil, which are the primary products of oils oxidation. Oxygen oxidises fats and oils are when they come in contact. The oxidation products have a disturbing smell and odour and can seriously alter the nutritional quality of the oil. Peroxide value is therefore used as a sign of decay of oils. Oils containing polyunsaturated fatty acids easily undergo oxidation, producing hydroperoxy acids resulting in a rancid odour and bad taste. Fresh oils have values not up to 10meq/kg, while values with the range of 20 to 40 meq/kg leads to rancid taste (Adelaja, 2006). The value obtained for TOSO in this research (**Table 1**) indicates that the oil has slowly undergone rancidity. This can however be overcome when properly stored.

Iodine value is the general accepted parameter for expressing the degree of carbon-carbon unsaturation in vegetable oils or their derivatives. It is used as the measure for the determination of unsaturation. Iodine value for oil or fat is defined as the weight of iodine absorbed by 100 parts of the sample. It is also useful in predicting the drying nature of oils. High iodine values are confirmations that oils are capable of producing cosmetics, vanishes and oil paints and varnishes and also serve eatble purposes (Dawodu, 2009). Adelaja (2006) reported that iodine value is also used for categorizing oils as non-drying, semi-drying or drying oils. Iodine values less than $100gI_2/100g$ oil are categorized as non-drying; those with 100-120 are semi-drying while those with 120 and above are drying oils. The low iodine value obtained for non-drying and semi-drying oils could be of importance in the production of candle, leather, lubricants etc. The iodine value obtained for TOSO in this work (**Table 1**) indicates the oil can be categorized as non-drying oil which found uses as mentioned above as well as in biodiesel production. Other examples of non-drying oils include *Citrullus lanatus* seed oil, *Terminalia catappa* seed oil etc.

Saponification value is a measure of the average molecular weight of the triacylglycerols in oil. This parameter is useful in the soap production industry as well as in biodiesel production processes. The smaller the saponification value the larger the average molecular weight of the triacylglycerols present in the oil and vice versa (Sawaya, Daghir, & Khan 1983). The value obtained in this research (**Table 1**) for TOSO shows that the oil will not be effective in the soap making industry (Akanni, Adekunle, & Oluyemi, 2005). It can however find use in the biodiesel production processes (Holbrook, 2001).

Holbrook (2001) reported that the free fatty acid value of oil is an indicator of the extent to which the oil has been subjected to enzymatic hydrolysis in the parent source before extraction. It occurs in vegetable oils either because of poor storage and contact with water or because of the presence of enzymes that rapidly cleave the fatty acids backbone. In refined vegetable oils, the lower the FFA the more acceptable the oil to the human palate. Therefore, the free fatty acid value of oil can be used as a measure of its quality. The free fatty acid value obtained for TOSO in this work (**Table 1**) is a bit high indicating that the oil seed has undergone an enzymatic hydrolysis. This however, can be overcome if the oil is properly handled and stored.

Comparing the results of the oil quality parameters obtained for TOSO in this work with other investigated oils from literature shows that TOSO compares quite well with those oils and can be exploited industrially.

Table 2: Comparison of the oil parameters of TOSO and other oils

Parameter	**TOSO**	***Citrullus lanatus* (White pumpkin)**	***Terminalia catappa* (Native pear)**	***Cucurbita pepo* (Pumpkin)**
Moisture content (%)	8.29	3.11	2.71	7.95
Colour	Light yellow	Yellow	Pale yellow	Dark brown
% oil yield	52.5	56.5	48 - 50	47.5
Specific gravity (g/ml)	0.900	0.942	0.91	0.900
% FFA	5.92	0.62	1.18	4.74
Acid value (mgKOH/g oil)	11.78	1.23	2.35	9.43
Peroxide value (meq/kg)	40.0	4.38	15.0	25.0
Iodine value (g/100g)	98.4	147.9	75.12	109.5
Saponification value (meq/kg)	105.19	165.6	122.02	119.21
State at room temperature	Liquid	Liquid	Liquid	Liquid

Conclusion

In conclusion, the results of the oil properties of TOSO obtained in this research indicate that the oil is non-drying oil which is very important in the production of lubricants, leather, and candle and to produce biodiesel. The oil yield indicates that the seed oil is highly economical. The saponification value shows that it cannot be used to produce soap while the acid value shows that the seed oil could serve edible purposes. The results obtained from this research work could further be used as baseline data to explore other usefulness of this seed oil for both domestic and industrial purposes.

Recommendation

More researches should be intensified to explore the use of this plant.

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