Characterization and fatty acid composition of oil extracted from *Croton penduliflours* seed

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ABSTRACT

The study aims to investigate the proximate, elemental and fatty acid composition of seed oil from *croton penduliflours* seed**.** The proximate analysis of the seed showed a composition of 14.65 moisture, 7.75 ash, 16.76 crude fibre, 24.67 crude fat, 25.82 protein and 10.359 g/100g carbohydrate respectively. Atomic absorption spectroscopy (AAS) was used to analyse the elemental composition of the seed and showed high content of potassium (413.06 mg/100g), calcium (288.48 mg/100g) and magnesium (190.34 mg/100g). The percentage oil yield was 34.9% (w/w). The oil physicochemical properties such as acid, peroxide, saponification and iodine value were 2.10 ± 0.13 mg/KOH/g, 6.0 ± 1.10 mgEq/kg, 176.6± 0.21 mg/KOH/g and 82.70 ± 0.10 gI_2/100g. The fatty acid composition was determined by Gas chromatography-mass spectrometry (GC-MS) and revealed petroselinic, linoleic and gondoic acid as dominant fatty acids having values of 42.96, 23.81 and 20.78% respectively. The results suggest the potential of the seed for use as animal feedstuff and its oil could be utilised for industrial purposes.

Keywords: Characterization, fatty acid, composition, oil, extracted, *Croton penduliflours* and seed

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1. INTRODUCTION

Seed oils are vegetable oil that is obtained from the seed of some plants, rather than fruit which are solid or liquid at room temperature. Most vegetable oils are seed oil. Some common examples are sunflower oil, linseed oil, castor oil, *Ximenia americana* oil, soybean oil and sesame oil. They consist of mixtures of organic molecules, which are mainly triacylglycerols, diacylglycerols, monoacylglycerols, free fatty acids and other minor components such as phospholipids, phytosterols, tocopherols and tocotrienols and hydrocarbons (Hamm *et al.,* 2013). The presence of fatty acids such as stearic, palmitic, oleic, linoleic and linolenic acids classify them as either essential or non-essential fatty acid. They could be also classified as saturated (no double bonds), monounsaturated (one double bond), and polyunsaturated fatty acids (multiple double bonds) (Enechi, 2001). The level of saturation or unsaturation of the fatty acid may be used to determine its area of application. Seed oils have been used extensively for domestic and industrial purposes. For instance linseed, perilla and tung oils with pronounce drying ability has been used for surface coating (Aigbodion *et al.,* 2003).

Some plant seeds contain a large amount of oils, which are viable alternative to petroleum resources for many applications. Many of the oils have been characterized and explored in the preparation of many chemical intermediates such as alkyd resins, metal carboxylates, biodiesel etc. (Folarin *et al.,* 2017; Musa and Usman, 2016; Ibanga *et al.,* 2015, Folarin *et al.,* 2013; Warra, 2013; Adesina and Amoo, 2013). However, so many are yet to be fully explored as industrial raw materials. One of such is *croton penduliflours* seed oil. *Croton penduliforus* (Euphorbiaceae) is a tropical evergreen plant widely distributed in Africa. Its seeds are used in folklore medicine as laxative, as well as a major component of herbal contraceptive and antifibroid decoction (Ojokuku *et al.,* 2015). *Croton penduliflorus* is a tree with a spreading crown growing up to 25 metres tall. The bole can be up to 50cm in diameter. The tree is harvested from the wild for local use as a medicine and source of timber. Croton seeds and its oil have been used in the treatment of a wide range of disorders in the past, both in pregnant and non-pregnant individual. In this present study, *Croton penduliforus* (*Euphorbiaceae*) oilseed has been investigated to determine its potential use as animal feedstuff and industrial oil.

2. MATERIALS AND METHODS

Materials

The seeds of *Croton penduliflorus* were bought at the popular Itoku' market in Abeokuta and were identified at the Federal University of Agriculture Abeokuta, Ogun State, Nigeria. These seeds were ground with laboratory mortar and pestle. Oil was extracted from the seed powder using soxhlet extractor.

Methods

Proximate chemical composition

The proximate analysis of *croton penduliflours* seed was determined. The moisture content was determined by drying in oven at 105°C until a constant weight was obtained. Ash was determined by weighing the incinerated residue obtained at 550°C for 3 hrs. Total crude protein content was determined using the Kjeldahl method. The total lipid in samples was determined by Soxhlet method. Available carbohydrates were calculated as 100% - [%(moisture + ash + fat + fibre+ protein)] (AOAC, 2000).

Oil extraction using soxhlet extraction

Milled sample weighing 30.0g g was placed in a thimble before adding the solvent (petroleum ether) into 250ml flat bottom flask. The set-up was heated at 60 °C for 4 h. This was repeated for 35g, 40g and 45g. After the extraction processes, the solvent was distilled out from the oil and the oil extracted was quantified (Omeje *et al.,* 2019) as:

$$Oil\ yield\ (\%) = \frac{Wi}{Wo}\ x\ 100$$

Where Wo is weight of sample and Wi, weight of oil extracted

Gas chromatography-mass spectrometry analysis

Gas chromatography-mass spectrometry (GC-MS-QP2010 plus Shimadzu, Japan) system is a very efficient technique commonly used for the identification and quantification of fatty acids in substances. The unknown organic compounds in the complex mixture found in the oil were matched with the National Institute of Standards and Technology (NIST) Libray (Omeje *et al.,* 2019).

Determination of acid value
25 ml of diethyl ether and 25 ml of ethanol was mixed in a 250 ml beaker. The resulting mixture was added to 10 g of oil in a 25 ml conical flask and a few drops of phenolphthalein were added to the mixture. The mixture was titrated with 0.1 M NaOH to the end point with consistent shaking for which a dark pink colour was observed and the volume of 0.1 M NaOH was recorded as Vo (Laboratory Handbook, 1997).

$$Acid\ Value = \frac{5.61\ x\ Vo}{Wo}$$

Wo = sample weight of oil and Vo, volume of NaOH used

Determination of saponification value
The indicator method was used as specified by ISO 3657 (1988). 2 g of the sample was weighed into a conical flask; 25 ml of 0.1N ethanoic potassium hydroxide was then added. The content which was constantly stirred was allowed to boil gently for 60 min. A reflux condenser was placed on the flask containing the mixture and a few drops of phenolphthalein indicator was added to the warm solution and then titrated with 0.5 M HCl to the end point until the pink colour of the inculcator just disappeared. The same procedure was used for other samples and a blank. The expression for saponification value (*SV*) is given by:

$$SV = \frac{5.61\ x\ N\ x\ (Vo - Vi)}{W}$$

where *Vo* – the volume of the solution used for the blank test, *Vi* – the volume of the solution used for determination, N– actual normality of HCl used, *W*– weight of the sample (Kyari, 2008).

Determination of iodine value
The method specified by ISO 3961 (1989) was used. 0.4 g of the sample was weighed into a conical flask and 20 ml of carbon tetra chloride was added to dissolve the oil. Then 25ml of Dam reagent was added to the flask using a safety pipette influenced chamber. A stopper was then inserted and the content of the flask was vigorously swirled. The flask was then placed in the dark for 2 h and 30 min. At the end of this period, 20 ml of 10% aqueous potassium iodide and 125 ml of water were added using a measuring cylinder. The content was titrated with 0.1 M sodium-thiosulphate solution until the yellow colour almost disappeared. A few drops of 1% starch indicator were added and the titration continued by adding thiosulphate drop-wise until blue coloration disappeared after vigorous shaking. The some procedure was used for the blank test and for other samples. The iodine value (*IV*) is given by the expression:

$$IV = \frac{12.69\ x\ C\ x\ (Vo - Vi)}{W}$$

where: *c* – concentration of sodium thiosulphate used, Vo – volume of sodium thiosulphate used for the blank, Vi – volume of sodium thiosoulphate used for determination, *W* – weight of the sample (Kyari, 2008).

Determination of peroxide value
To 1 g of the oil sample, 1 g of potassium iodide and 20 ml of solvent mixture (glacial acetic acid/chloroform, 2/1 by volume) were added and the mixture was boiled for one minute. The hot solution was poured into a flask containing 20 ml of 5% potassium iodide. A few drops of starch solution were added to the mixture and the latter was titrated with 0.025 N sodium thiosulphate and the peroxide value was determined as follows:

$$PV = \frac{S\ x\ N\ x\ 1000}{W}$$

Where *S* – volume of $Na_2S_2O_3$, *N* – normality of $Na_2S_2O_3$, *W* – weight of oil sample (g) (Kyari, 2008).

4. RESULTS AND DISCUSSION

The proximate compositions of *Croton penduliflours* seed is presented in Figure 1. The crude protein content is 25.82 g/100g, though inferior to soybean (36.70 g/100g), but appreciably higher than those of cowpea (23.1 g/100g), maize (8.9 g/100g), and some commonly cultivated legumes (Nwokolo, 1987; Kadwe et al., 1974). The crude fat content (24.67 g/100g) is found to be higher than those of soybean (20.10 g/100g), cowpea (15.0 g/100g) and maize (3.9 g/100g). Balogun and Fetuga (1986) reported a lower protein of 21.06 and higher fat of 27.84 g/100g contents on leguminous crop seeds. The seed meal could possibly be a good source of protein supplement in animal feed. Ash content of 7.751 g/100 g suggests a mineral level suitable for animal feed. With total crude fat, crude fibre and carbohydrate contents of 24.67, 16.76 and 10.36 g/100 g respectively, *croton penduliflours* seed could be a good source of energy and edible oil, and thus a useful supplement in animal feeding.

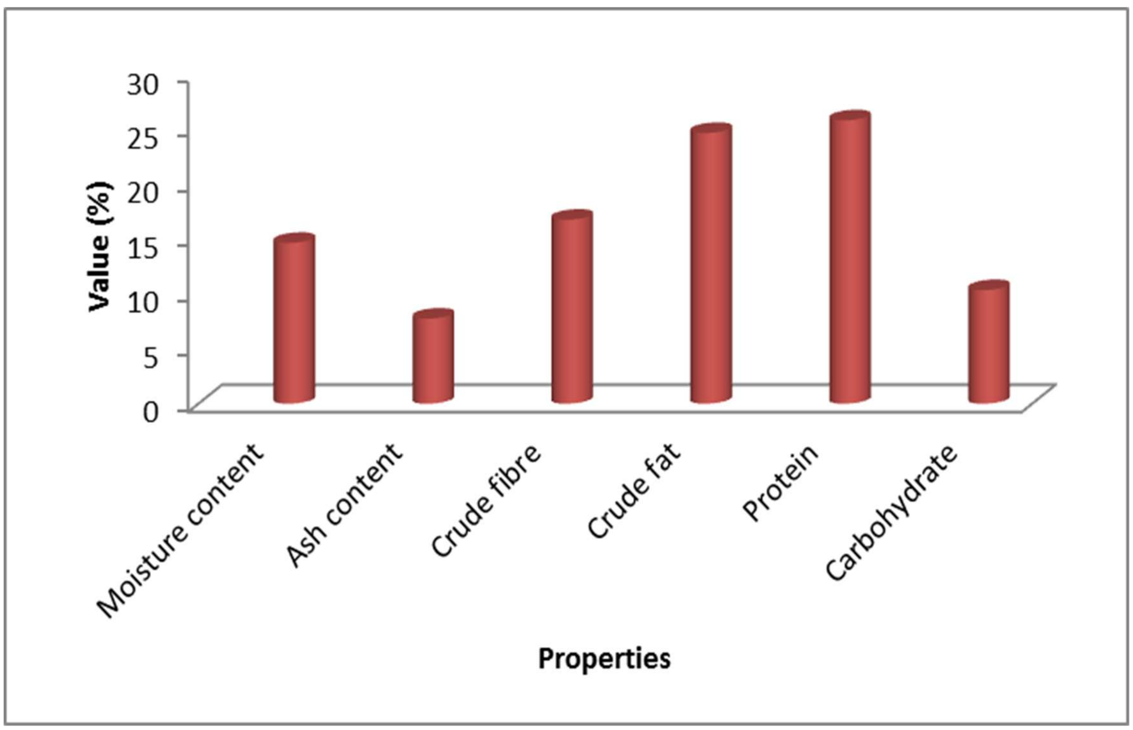

Figure 1: Proximate Composition of *Croton penduliflours* seed

Figure 2 shows the elemental composition of *Croton penduliflours* seed. The result revealed that potassium (413.07mg/100g), calcium (288.48 mg/100g) and magnesium (190.35mg/100g) are the most abundant minerals and seems to be higher than those of the cultivated staples (Apata and Ologhobo, 1994; Singh *et al.,* 1980).

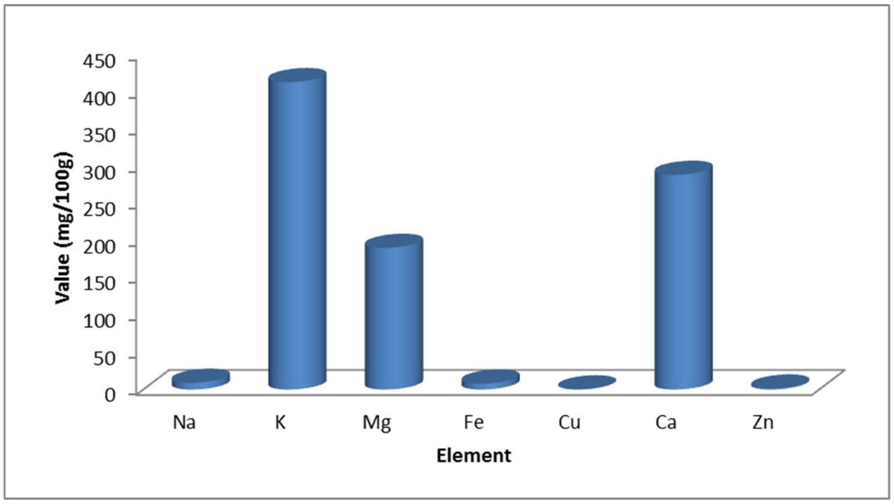

Figure 2: Elemental Composition of *Croton penduliflours* seed

The percentage oil yield extracted from the seed using petroleum ether is 34.9% which is relatively higher when compared with African star cherry (23.80%) (Omeje *et al.,* 2019), whereas lower when compared with *Ximenia americana* seed oil (45.7%) (Oladipo *et al.,* 2013) and castor seed oil (44.69%) (Onukwli and Igbokwe, 2008). The physicochemical properties of the *croton penduliflours* seed oil (CPSO) are shown in Table 1. The oil is a transparent brownish yellow liquid. The acid value of 2.10±0.13 mg/KOH/g suggests low in-vivo lipolytic activities in the seed and indicates a good non-degraded state of the oil and falls within limits for industrially useful oils (Oyedeji and Oderinde, 2006). However, it is slightly higher than linseed oil with 1.0 mg/KOH/g (Majumder, 1990). Acid value is the measure of percentage content of free fatty acids in a substance, and degree of rancidity (Ononogbu, 2002). It is used as a parameter in determining freshness of the oil (Ononogbu, 2002).

The peroxide value of 6.0±1.10 mEq/kg suggests that the oil is slightly susceptible to oxidative rancidity (Adebayo *et al.,* 2012). The saponification value of CPSO is 176.6±0.21 mgKOH/g which is lower in comparison of *Ximenia americana* seed oil (XASO), castor oil (CO), rubber oil (RO) and linseed oil (LO) with 178.5, 182, 181.14 and 185-194 mgKOH/g respectively (Onukwli & Igbokwe, 2008; Ikhuoria & Okieimen 2005; Majumder, 1990). This suggests that the oil may be used for the preparation of soap. The iodine value of 82.70±0.10 gI_2/100g is similar to that of castor seed oil whereas lower in comparison of those of linseed and rubber seed oil with 188 and 136.2 gI_2/100g respectively. This value suggests that CPSO is non-drying oil and may be suitable for use as plasticizer and not alkyd resin.

Table 1: Physiochemical properties of C*roton penduliflours* seed oil

Property	CPSO	CO	RO	LO	XASO
Colour	Brownish yellow	-	-	-	-
Acid Value (mgKOH/g)	2.10±0.13	2.89	19.18	1.0	16.13
Iodine Value (gI_2/100g)	82.70±0.10	82.8	136.2	188.0	152.28
Saponification Value (mgKOH/g)	176.60±0.21	182.0	181.14	185-194	178.5
Peroxide Value (mgEq/kg)	6.00±1.10	6.7	-	-	31.25
Oil yield (%)	34.9	-	-	-	-

The fatty acid composition of *Croton penduliflours* seed oil is shown in Table 2. The result shows that the seed oil contains twelve fatty acids of which seven are unsaturated yielding a total unsaturation of 87.91% and this is lower when compared with linseed (91.3%) (Tarandjiiska *et al.,* 1996) and *Ximenia americana* seed oil (92.92%) (Folarin *et al.,* 2011; Eromosele & Eromosele, 2002). The amount of the abundant fatty acids are 42.96, 23.81 and 20.78% for petroselinic, linoleic and gondoic acid respectively. The oil may have nutritional value due to the presence of linoleic acid, an essential fatty acid which plays an important role in biosynthesis of prostaglandins (Al-Jassir *et al.,* 1995). The toxicological analysis of the oil becomes imperative due to the presence of erucic acid to ascertain its edibility (Oladipo *et al.,* 2013).

Table 2: Fatty acid composition of *croton penduliflours* seed oil

Fatty Acid	**Value (%)**
Crotonic ($C_{4:1}$)	0.02
Caprylic ($C_{8:0}$)	0.10
Capric ($C_{10:0}$)	0.42
Tridecyclic ($C_{13:0}$)	0.05
Vaccenic ($C_{18:1}$)	0.03
Palmitic ($C_{16:0}$)	8.41
Linoleic ($C_{18:2}$)	23.81
Petroselinic ($C_{18:1}$)	42.96
Linoleoyl chloride ($C_{18:2}$)	0.21
Gondoic ($C_{20:1}$)	20.78
Methyl 18-methylnondecanoate ($C_{20:0}$)	3.11
Erucic ($C_{22:1}$)	0.10
Total unsaturation	87.91

5. CONCLUSION

The extracted oilseed gave an oil yield of 34.9% with a transparent brownish yellow liquid at room temperature. *Croton penduliflours* seed oil comprised of 87.91% unsaturation with dominant fatty acids of petroselinic, linoleic and gondoic acid. The abundant of petroselinic acid suggests its use for cosmetic as it is an effective anti-aging and anti-inflammatory agent. Some of its physicochemical properties such as iodine and saponification values suggest that the oil is non-drying and thus, may be used for soap production. The result of the proximate composition suggests that *Croton penduliflours* seed may be a good source of energy and also useful supplement in animal feeding.

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