https://dx.doi.org/10.4314/dujopas.v10i2b.32
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 10 No. 2b June 2024*

Extraction and Quantification of Oil Extracted from Seeds of Underexploited Tropical Plants in Akwa Ibom State, Nigeria.

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Abstract
Oil was extracted from seeds of Coula edulis, Dacryodes edulis, Garcinia kola and Cola lepidota, using η-hexane, chloroform and a fraction of η-hexane and chloroform (1:1) as extracting solvents. The extraction was carried out at a temperature of 60 ℃. Using η-hexane as the extracting solvent, 42.5%, 40.1%, 24.63% and 35.73% were the yields of oil extracted from C. edulis, D. edulis, G. kola and C. lepidota respectively. Values recorded for chloroform-extracted oil were 28.7%, 25.4%, 10.83% and 21.93% respectively. Using a fraction of η-hexane and chloroform (1:1), the experimental seeds had percentage oil yield of 31.4, 27.92, 13.53 and 24.63 respectively. The results show that C. edulis and D. edulis had high oil content, when compared with G. kola and C. lepidota. These results suggest that η-hexane remains a veritable solvent for extraction of oil from seeds of tropical plants.

Keywords: Extract, seed, oil**,** η-hexane, chloroform.

INTRODUCTION
Plant seeds have been used for a very long time now as sources of vegetable oil (Ochigbo and Paiko, 2011). Although many plant parts may yield oil, in commercial practice, oil is extracted primarily from seeds. Therefore, seed oils can be referred to as vegetable oils. They are important sources of nutritional oils and are of industrial and pharmaceutical importance (Evwierhoma and Ekop, 2016).

Seed oils have continued to attract enormous attention as potential source of platform chemicals at both laboratory and industrial scale (Sharmin *et al.,* 2012). Nonetheless, yield of seed oil will depend among others, on oilseed variety, soil and environmental conditions around the resource oil-bearing plant, as well as on pretreatment procedure, and the particular extraction method(s) used (Yusuf, 2016).

All over the world, an estimated 40 million tons of fats and oils are consumed by man annually (Dhiman *et al.,* 2009). Increase in world population has led to a drastic increase in the demand for edible and non-edible oils. As a result, Sam *et al.* (2008) observed that there is an acute

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shortage of edible oils and fats in Africa. The shortfall, according to them, is being largely met by increased imports of oils from the developed countries, which puts a heavy strain on the foreign exchange position of several African countries, including Nigeria.

Coula edulis Baill belongs to the family of Olacaceae, and is commonly known as "African walnut', due to its edible seeds (Bukola *et al.,* 2008). It is referred to as *Ekom* (Ibibio and Efik), *Udo* (Igbo), *Ivianlegde* (Edo) and *Asala* (Yoruba) in Nigeria, where the nut obtained from the fruits serves as good source of nutrients to the local people (Ekop and Eddy, 2005).

Garcinia kola Heckel is a species of flowering plant and belongs to the Clusiaceae family (Bennett and Saliu, 2022). Its common name is bitter kola. It is called Orogbo by the Yorubas, Aka ilu (Igbo), Namijin goro (Hausa), Efiari (Efik), and Efiat (Ibibio) (Stephen *et al.,* 2017). Iwu (1993) reported that *G. kola* is an indigenous medicinal plant found in the rain forests of Central and Western Africa, especially Benin, Cameroon, Democratic Republic of Congo, Cote d'Ivoire, Gabon, Ghana, Liberia, Nigeria, Senegal, and Sierra Leone. In Nigeria, it is common in the Southwestern States and Edo State (Otor *et al.,* 2001).

Cola lepidota K. Schum, commonly known as monkey kola, is a member of the *Cola* species that yield edible tasty fruits (Okwu *et al.,* 2020). The plant belongs to the same botanical family Malvaceae and sub-family Sterculioideae as the popular West African kola nuts (*Cola nitida* and *C. acuminate*), grown for their masticatory and stimulating nuts (Okudu and Asumugha, 2018). Meregini (2005) observed that *Cola pacycarpa, Cola lepidota* and *Cola lateritia* are among the species commonly referred to as monkey kola. The seeds of the monkey cola species are obliquely ovoid with two flattered surfaces, rough and reddish brown or green; but not edible unlike the seeds of cola nut (*Cola nitida*) (Oni *et al.,* 2020).

Dacryodes edulis (G. Don) H. J. Lam, commonly known as African Pear, is a well-known plant in West Africa. In Igbo, it is called *ube*, while the Ibibios call it *eben.* The plant belongs to the family Burseraceae. African Pear is an indigenous fruit tree found in West and Central Africa, as well as in the Gulf of Guinea (Zofou *et al.,* 2013), but is native to southern Nigeria and perhaps to Cameroon (Vivien and Faure, 1996). It is a medium-sized, evergreen tree attaining a height of 18 – 40 meters in the forest but not exceeding 12 meters in plantations (Zofou *et al.,* 2013). It rarely grows wild. Thus, the exact natural area of distribution is obscure (Verheij, 2002).

The present unpredictability in the global food supply, the increased demand in searching for other food sources with general accessibility and willingness of weary consumers to consume functional food that will add values to their health prompted this study. To deal with this increasing demand, exploration of the potentials of some newer and underutilized plant resources for the production of oils is needed.

Over the years, several researches into the extraction of oil from seeds of various plants have been undertaken. Most of the extractions were carried out using only η-hexane as the solvent. Nevertheless, this present study therefore aimed to extract oil and estimate yield from *Coula edulis, Dacryodes edulis, Garcinia kola* and *Cola lepidota* using η-hexane, chloroform and a fraction of n-hexane and chloroform (1:1).

Materials and Methods

Sample Collection

Fresh and healthy seeds of *C. edulis, D. edulis, G. kola* and *C. lepidota* were randomly purchased from local cultivars at Itam, Akpan Andem and Offiong Etok Markets in Akwa Ibom State, Nigeria. The seeds were authenticated by a Taxonomist in the Department of Botany, Akwa Ibom State University, Nigeria.

Extraction of Oil

Fruits of the research plants were exfoliated, to get the seeds. The seeds had foreign materials and dirt which were separated by handpicking. The cleaned seeds were broken down (separately) into smaller pieces using mortar and pestle. The chopped seeds were then dried under room temperature in the Department of Botany Laboratory, Awa Ibom State University, Mkpat Enin, Nigeria. Upon drying, the seeds were separately pulverized with a laboratory blender (LEXUS MG-2053 OPTIMA).

Soxhlet extraction as described by Adebayo *et al.* (2012) was employed in extracting oil from the experimental seeds. 300 mL of each of the solvents (η-hexane, chloroform and a fraction of *n*-hexane and chloroform) respectively was poured into a round bottom flask. For each seed, 10 g of the milled sample was loaded into a thimble and was inserted in the center of the extractor. The soxhlet was heated at 40 – 60 °C.

When the solvent was boiling, the vapour rose through the vertical tube into the condenser at the top. The liquid condensate dripped into the filter paper thimble in the center which contained the solid sample to be extracted. The extract seeped through the pores of the thimble and filled the siphon tube, where it flowed back down into the round bottom flask. This was allowed to continue for 3 hours. It was then removed from tube, dried in the oven, cooled in the desiccators and weighed again to determine the amount of oil extracted. At the end of the extraction, the resulting mixture containing the oil was heated to recover solvent from the oil. Each sample was run in triplicate and results tabulated.

The oil was concentrated by heating in the oven at 60 °C to ensure complete evaporation of the solvent and latter cooled in a desiccator. The percentage oil yield for each seed sample was estimated using the expression:

$$\text{Oil Yield (\%)} = \frac{weight\ of\ oil\ extracted}{weight\ of\ sample}\ x\ 100$$

Chemicals Used

All chemicals used for the experiments were of analytical grade and products of British Drug House, Poole, England.

Statistical Analysis

All extractions were performed in triplicates. Results were expressed in mean ± SD. Statistical significance was established using Analysis of Variance (ANOVA).

RESULTS

Percentage yields of oil extracted from seeds of *C. edulis, D. edulis, G. kola* and *C. lepidota,* using η-hexane, chloroform and a fraction of η-hexane and chloroform (1:1) are presented in Plate 1 and Figures 1 – 3 below.

Plate 1: Oil extracted from experimental seeds

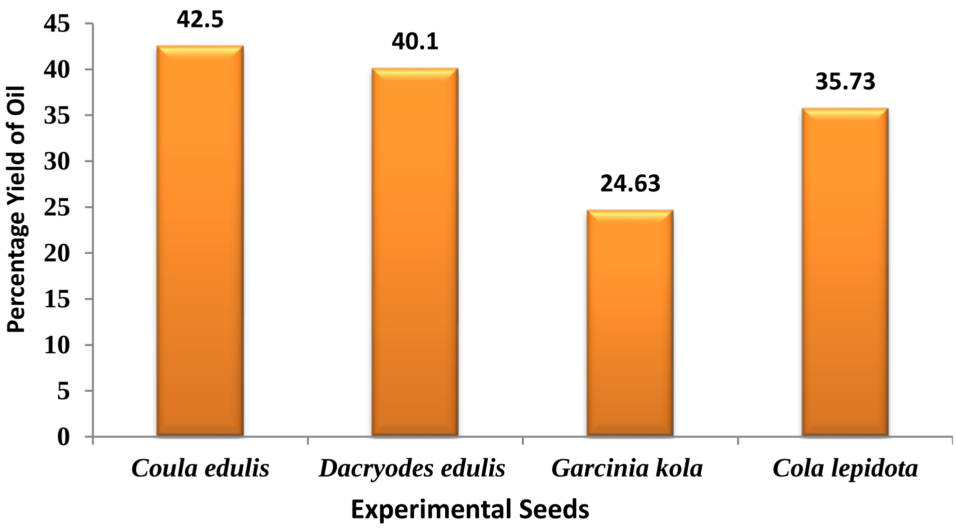

Figure 1: Result of Oil Extraction from Sample Seeds, using η-Hexane

Percentage yields of oil extracted from seeds of *C. edulis, D. edulis, G. kola* and *C. lepidota,* using η-Hexane are shown in Figure 1. According to the chart, *C. edulis* seeds produced the highest yield of oil (42.5%). This value was closely followed by seeds of *D. edulis*, which produced 40.1% of oil. 35.73% was recorded for *C. lepidota* seed oil extracted using η-Hexane. Of the four experimental seeds, *G. kola* seeds produced the least yield with a value of 24.63%.

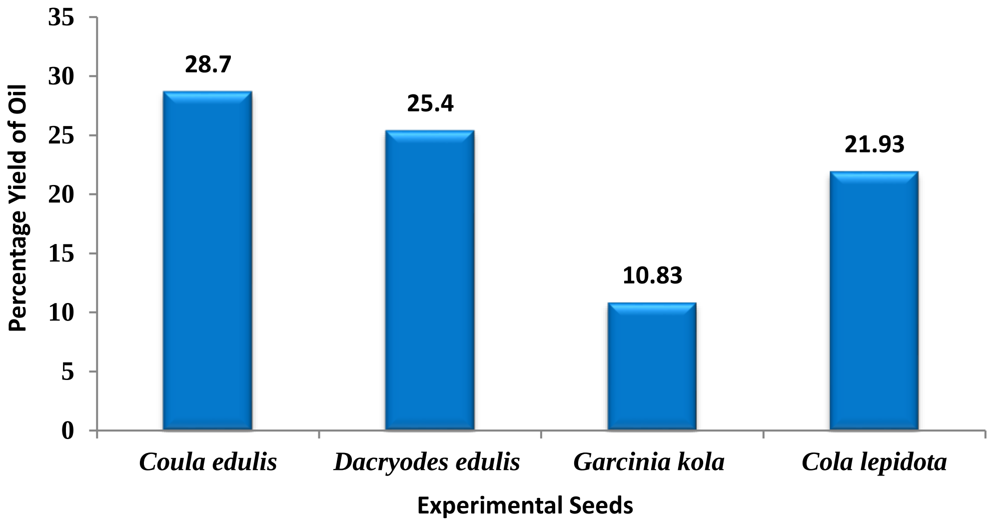

Figure 2:Result of Oil Extraction from Sample Seeds, using Chloroform

Figure 2 shows the percentage yields of oil extracted from *C. edulis, D. edulis, G. kola* and *C. lepidota,* using chloroform. As seen on the bar chart, the percentage yields ranged from 10.83 to 28.7%. *G. kola* seed oil had the least yield with 10.83%. *C. lepidota* was next in terms of yield, with 21.93%. *D edulis* seeds yielded 25.4% of oil, while *C. edulis* seeds produced oil with a value of 28.7%, to be the highest in terms of oil yield, using chloroform as extracting solvent.

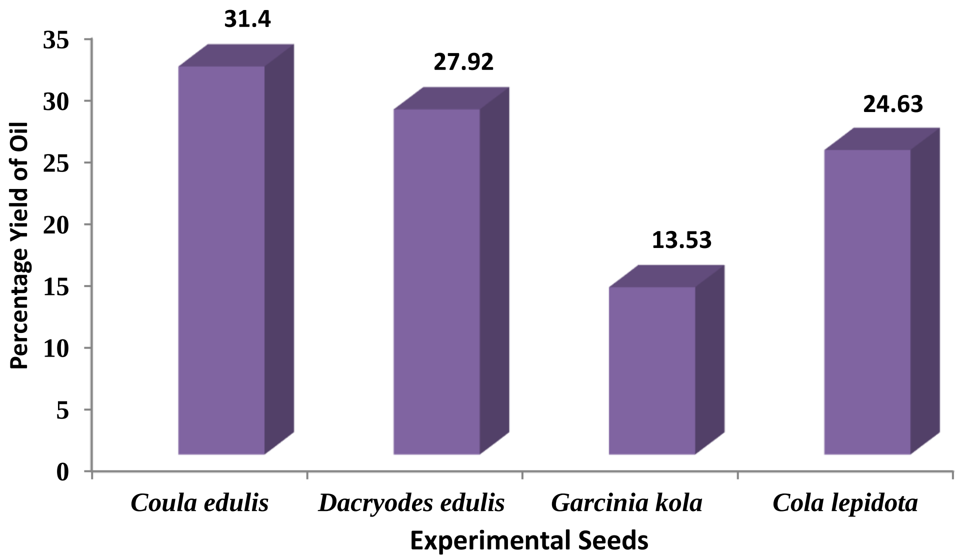

Figure 3: **Result of Oil Extraction from Sample Seeds, using η-Hexane:Chloroform Fraction (1:1)**

Results of oil extraction from seeds of *C. edulis, D. edulis, G. kola* and *C. lepidota,* using η-hexane:chloroform fraction (1:1) are shown on Figure 3. The bar chart shows that *C. edulis* seed had the highest oil yield, with 31.4%. This value was followed by *D. edulis* seeds, which had 27.92% value. Seeds of *C. lepidota* and *G. kola* had 24.63% and 13.53% oil yield respectively.

DISCUSSION

Oil yields from experimental seeds, using η-Hexane as extracting solvent, were in the range of 25% and 43%. *C. edulis* seed oil had the highest yield with 42.5%. This result was higher than that recorded by Ekissi *et al.* (2016) for *C. edulis* seed oil extracted using η-Hexane (34.85%). *G. kola* seed oil had the least percentage yield (24.63%). These results were akin to those reported by Kyari (2008) for *Schorocarya birrea* (42%) and *Blighia sapida* (26%) respectively.

When extracting the oils, using chloroform, percentage yield recorded was in the range of 11% and 29%. The highest yield (28.7%) was recorded for *C. edulis.* Next to this was *D. edulis,* which had 25.4%. *C. lepidota* and *G. kola* had a percentage yield of 21.93 and 10.83 respectively.

For oils extracted using a fraction of η-Hexane and chloroform (1:1), results gotten were in the range of 13.53% and 31.4%. These results were somewhat similar to those recorded using individual solvents (η-Hexane and chloroform). This implies that *C. edulis* had the highest value (31.4%), while *G. kola* retained its spot with the least yield (13.53%). *D. edulis* and *C. lepidota* had 27.92% and 24.63% respectively.

Generally, *C. edulis* seeds provided a greater yield of oil (42.5%, 28.7% and 31.4%), when compared with seeds of *D. edulis, G. kola* and *C. lepidota*. The oil yields compare favourably with the values in seeds of groundnut (46%) (Adebayo *et al.,* 2012), Shea butter (34%) (Kyari, 2008) and palm kernel (44.6%) (Akbar *et al.*, 2009).

Seeds of *G. kola* produced lower oil yield, according to this study. When extracted with η-Hexane, the seeds produced 24.63% of oil. 10.83% and 13.53% were recorded when extracted with chloroform and a fraction of η-Hexane and chloroform (1:1) respectively. These results compare favorably with some underutilized plant seed oil such as *Persea Americana*, which has a yield of 10.8% (Sam *et al.,* 2008), *Detarium microcarpum*, with percentage oil content of 7.42% and 13% for mango seed (Nzikou *et al.*, 2009).

The results show that seeds of *C. edulis* are richer in oil than all other seeds used for this experiment and most of the conventional oilseeds. These variations between oil yields in seeds could be attributed their cultivation climate, ripening stage, harvesting time and the extraction method employed (Egbekun and Ehieze, 1997).

In this study, η-Hexane was also found to be the best solvent for oil extraction from seeds of *C. edulis, D. edulis, G. kola* and *C. lepidota,* since maximum oil extraction was obtained with Soxhlet method using η-Hexane (42.5%, 28.7% and 31.4% respectively). This justifies its significant use in oil extraction methods from most plant products (Tchiegang *et al.,* 1998).

CONCLUSION

All the seeds examined in this work have been shown to contain oils in reasonable levels. However, the results reported in this present study revealed that seeds of *C. edulis* and *D. edulis* have higher oil contents than those of *G. kola* and *C. lepidota.* η-Hexane has also been confirmed to be a veritable solvent for extraction of oil from seeds of plants using Soxhlet apparatus.

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