CHEMICAL COMPOSITION OF SEEDS AND SEED OIL OF *Afraegle paniculata* (Rutaceae)

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Received 15 March 2021; accepted 29 March 2021, published online 10 April 2021

ABSTRACT

Afraegle paniculata (Schumach. & Thonn.) Engl. commonly known as Nigerian powder-flask is a plant of rutaceae family found in West Africa from Senegal to Nigeria. The chemical composition of seeds and seed oil of *Afraegle paniculata* were evaluated in this study. The seed oil was obtained by soxhlet extraction using n-hexane. Chemical composition analyses involved proximate, mineral element, physicochemical and phytochemical. The percentage mean value of the proximate analysis revealed that the seeds contained 28.81 ± 0.02 % crude fat, 25.03 ± 0.12 % crude protein, 10.90 ± 0.03 % moisture, 3.11 ± 0.01 % ash, 25.19 ± 0.02 % crude fibre and 6.96 ± 0.14 % carbohydrate. The mineral element analysis result showed that potassium (114.87 mg/l) was the predominant mineral element followed by magnesium (47.20 ± 0.037 mg/l) and sodium (45.37 ± 0.53 mg/l). Other minerals present were calcium (2.12 ± 0.014 mg/l), iron (1.12 ± 0.028 mg/l), copper (0.41 ± 0.002 mg/l), zinc (0.39 ± 0.094 mg/l) and manganese (0.29 ± 0.005 mg/l). The oil was liquid at room temperature and golden yellow in appearance. The recorded pH, acid, peroxide, iodine, saponification, ester and oil yield values were 3.94, 1.29 mgKOH/g, 17.57 meq/kg, 42.24 mgI₂/100g, 203.76 mgKOH/g, 202.47 mgKOH/g, 40.77 % w/w respectively. The presence of alkaloids, saponins, terpenoids, steroids and anthraquinone were evident in the phytochemical screening of the seed oil. Nutritional profile of *A. paniculata* seed could offer a scientific basis for use of the seeds and oils both in human diet and some commercial products. Keywords: *Afraegle paniculata*, proximate, mineral elements, physicochemical and phytochemical.

INTRODUCTION

Recent studies have revealed that some seed oils could find their usefulness as raw materials in formulation of paints depending on the quantity and nature of oil derived from them, as well as animal feeds. [1]. Dietary fats and oils are lipids derived from plants. Although several plant parts may yield oil, commercially, oils are extracted primarily from seeds. Seeds have calorific and nutritive values thereby, contributing to their significance in diets. They are also good sources of edible oils [2]. These oils are increasingly becoming important and various analyses have been carried out primarily because of extensive demands for oils both for human consumption and for industrial applications. The characteristics of oils from different sources depend mainly on their compositions and no oil from a single source can be suitable for all purposes [3]. Lipids derived from plants are widely known to affect serum cholesterol homeostasis and play a crucial role in the development or prevention of disease. *A. paniculata* almonds of the Côte d'Ivoire species have relatively high fat matter (38.4

of development of cancer, atherosclerosis and heart disease, which are the main causes of death in developed countries [4]. There is a bond between the concentration of lipids and the tendency of developing coronary heart disease (CHD), specifically, resulting in blood cholesterol [5]. Human and animals studies have shown that dietary saturated fatty acid increases low density lipoprotein cholesterol (LDLC) concentration and plasma total cholesterol (TC), whereas, they are lowered by polyunsaturated fatty acids [6]. Therefore, there have been great interests in determining the health benefits of vegetable oils (high in mono- and polyunsaturated fatty acids) in relation to risk factors for cardiovascular disease (CVD) [7]. *Afraegle paniculata* (Schum and Thonn) Engl. belongs to Rutaceae family and commonly found in West Africa. *A. paniculata* is a shaft 8 to 15 m tall, with a trunk diameter between 25 and 40 cm. Its alternating leaves (leaflets 3) are 8 to 16 cm long. Its fruits are globular or ovoid, like a big orange (6-8 cm in diameter at the mature age). *A. paniculata* is cultivated in the villages for its multiple uses; nutritional, medicinal etc. It is used as a

traditional medicine in the treatment of malaria in Ghana [9] and also for hypertension and infertility [10]. However, the nutritional value of *Afraegle paniculata* seed oil of Nigeria species has not been reported. Therefore, this study aimed at determining the nutritional values of *Afraegle paniculata* seed and seed oil.

MATERIALS AND METHODS

Sample Collection and Identification

Afraegle paniculata fruits were collected from Ajayi Crowther University campus, Oyo, Oyo State, Nigeria. The fruit was identified and authenticated at Forestry Research Institute of Nigeria, Herbarium (111394FHI).

Extraction of seed oil

A known quantity of the ground seed was packed into a large filter paper and placed into the thimble. The seed kernel oil was extracted using soxhlet extraction method [11] with n-hexane (b.p 68 °C) as refluxing solvent for 8 h. At the completion of the extraction process, the oil was recovered from the mixture by distillation and stored prior to analysis.

Proximate Analysis

Moisture content was determined by drying the powdered seed kernel to constant weight at 105 °C. Ash content was evaluated according to the procedure of Otitologbon *et al.* [12]. Crude protein ($N \times 6.25$), crude fiber and crude fat analysis were as described in literature [13] and carbohydrate calculated by difference: $[100 - (\text{moisture} + \text{ash} + \text{crude fat} + \text{crude fibre} + \text{crude protein})]$ as outlined in literature [14].

Mineral Element Analysis

One gram of the sample was digested and then subjected to elemental analysis following Umran procedure [15]. Potassium and sodium were evaluated using Jenway PFP7 Flame Photometer while calcium, magnesium, zinc, copper, iron, and manganese were estimated using PerkinElmer A Analyst 200 Atomic Absorption Spectrophotometer.

Qualitative and Quantitative Phytochemical Screenings

Phytochemical screenings (qualitative and quantitative) were carried out on the sample using standard procedures described by Sofowora [16], Solomon *et al.* [17] Ayoola *et al.* [18], Obdoni [19] and Indumathi [20].

Physicochemical analysis

Physicochemical analyses for acid value (free fatty acid), saponification value, iodine value, ester value and specific gravity were in accordance to standard method [21] and Saad [22].

RESULTS AND DISCUSSION

Physical characterization of *A. paniculata* fruit

Presented on Table 1 is the result of the physical properties of *A. paniculata* fruit. The shape of the fruit is globose with a hard epicarp. The fruit which has brownish mesocarp and 6-8 segments embedded with numerous white seeds immersed in sticky mucilage was observed to be greenish-yellowish. The average weight, width and length obtained for randomly selected 30 fruits were 259.81 g, 27.51 cm and 26.48 cm respectively. The weight of 100 seeds was 24.57 g.

Proximate composition of *A. paniculata* seeds

Proximate analysis result revealed that *A. paniculata* seeds are rich in nutrients especially crude fat 28.81 ± 0.02 %, crude protein 25.03 ± 0.12 % and crude fibre 25.19 ± 0.02 %. The moisture content of any food is an index of its water activity and it is a measure of stability and susceptibility to microbial contamination [23]. The moisture content of *A. paniculata* seeds 10.90 ± 0.03 % was lower than 53.75 ± 2.02 % reported by Lakht-e-Zehra *et al.* [24] for *Aegle marmelos* (Rutaceae) seeds. Moisture content depends on the environmental conditions such as humidity, temperature and climate and also storage condition. The ash content 3.11 ± 0.01 % was similar to the value reported for *A. marmelos* seed (3.0 ± 0.12 %) [25]. It is higher than 1.56 ± 0.07 noted in literature for Karachi region grown species of the same *A. marmelos* L. [24]. Ash content is a reflection that the seeds are rich in mineral elements. Crude fibre which is above 12 % implies high level of undigested cellulose [26]. The crude fibre of *A. paniculata* seeds 25.19 ± 0.02 % was much higher than 1.01 ± 0.10 % of *A. marmelos* L. [24]. High amount of fibre in diet is necessary for elimination of wastes; it can be used to lower serum cholesterol and the risk of coronary heart disease, constipation, hypertension, diabetes, colon and breast cancer [27] The protein content 25.03 ± 0.12 % was

quite higher than the range 15-22 % reported for some conventional oil seeds (*Adenopus breviflorus* and *Cumeropsis edilis*) and *Aegle marmelos* seeds [24, 25, 28]. High protein content of the seeds suggests its use in the management of protein deficiency; the high crude fat 28.81 ± 0.02 % which is similar to that of soy bean (28.2 %) as noted by Ogbemudia [29] is an indication that the seeds could be a good source of oil. The carbohydrate content 6.90 ± 0.14 % is lower than 18.88 ± 0.80 % of *A. marmelos* seeds [24].

Mineral element composition of *A. paniculata* seeds

The result presented on Table 3 showed that the seeds of *A. paniculata* have high level of potassium (114.87 mg/L), magnesium (47.20 ± 0.037 mg/L) and sodium (45.37 ± 0.53 mg/L). The high level of potassium in *A. paniculata* seeds was in agreement with the report of Bamba [30] of the Cote d'Ivoire

species. Potassium is an essential nutrient with an important role in the synthesis of protein and amino acids. Magnesium plays important role in carbohydrate metabolism, nuclei acid and photosynthesis and also as binding agents of cell walls [31]. It also helps in regulating the acid alkaline equilibrium in the body. It has been reported that high magnesium level in drinking water helps in resisting heart disease [32]. Sodium is a major cation in extracellular fluid, which helps in regulation of acid-base equilibrium, maintenance of osmotic pressure in the body and protection against dehydration [33]. The addition of *A. paniculata* seed oil in diet could help to prevent dietary deficiency of potassium, magnesium and sodium due to the fact that the seeds are rich in these three elements aforementioned. The seeds also contain calcium, iron, copper, manganese and zinc in minute quantity.

Table 1: Physical characterization of *Afraegle paniculata* fruit

Parameter	Mean
Fruit length (cm)	26.48
Fruit width (cm)	27.51
Fruit weight (g)	259.81
Seed weight (g/100 seeds)	24.57
Colour of seed	White
Colour of fruit	Green/yellow
Shape of fruit	Globose
Fruit epicarp	Hard
Colour of mesocarp	Brown

Table 2: Proximate composition % of *Afraegle paniculata* seeds

Parameters	Mean $\pm$ SD
Crude fat	28.81 ± 0.02
Crude protein (N $\times$ 6.25)	25.03 ± 0.12
Moisture content	10.90 ± 0.03
Ash content	3.11 ± 0.01
Crude fibre	25.19 ± 0.02
Carbohydrate	6.96 ± 0.14

Table 3: Mineral element composition of *Afraegle paniculata* seeds (mg/L)

Metal	Mean $\pm$ SD
Iron	1.12 ± 0.028
Copper	0.41 ± 0.002
Magnesium	47.20 ± 0.037
Calcium	2.12 ± 0.014
Manganese	0.29 ± 0.005
Zinc	0.39 ± 0.094
Sodium	45.37 ± 0.53
Potassium	114.87

Table 4: Physicochemical properties of *A. paniculata* seed oil

Parameters	Value	(Bamba <i>et al.</i> , 2015)[8]
Acid value (mgKOH/g oil)	1.29	2.08 ± 0.91
Peroxide value (meqO ₂ /kg oil)	17.57	3.43 ± 0.19
Iodine value (mgI ₂ /100g oil)	42.24	105.75 ± 2.11
Saponification value (mgKOH/g oil)	203.76	200.55 ± 1.40
Ester value (mgKOH/g oil)	202.47	197.75 ± 1.40
Oil yield (% wt/wt)	40.77	$38.40 \pm 0.5\%$
State at room temperature	Liquid	Liquid
Colour	Golden yellow	Yellow gold
pH	3.94	-
Specific gravity	0.878g/cm	0.8844 ± 0.0001

Table 5: Qualitative phytochemical screening of *A. paniculata* seed oil

Test	Oil sample
Saponins	+
Tannins	-
Flavonoid	-
Cardiac glycosides	-
Anthraquinones	++
Terpenoids	+
Steroid	+
Alkaloid	+
Phenol	-

Key: (+) present; (-) absent

Table 6: Quantitative phytochemical screening of *A. paniculata* seed oil

Test	Oil sample(g)	Average yield(g)	% Yield
Alkaloid	2.0	0.003	0.15
Saponins	1.0	0.062	6.25
Terpenoid	1.0	0.061	6.10

Physicochemical properties of *A. paniculata* seed oil

A. paniculata seed oil was golden yellow in colour and liquid at room temperature (Table 4); this is in agreement with the observation for the oil of the Cote d'Ivoire species [8]. The percentage oil yield 40.77 % was closely similar to 38.4 % reported for its counterpart from Cote d'Ivoire. It is however higher than those of some conventional oil seeds: soybean (17.0-21.0 %) and cotton (15.0-24.0 %) [34]. *A. paniculata* seed is a rich source of oil and could be classified as oil rich seed. The acid value 1.29 mgKOH/g oil of *A. paniculata* was slightly lower than that of Cote d'Ivoire species; 2.08 mgKOH/g oil [8]. The value is much lower than the maximum acceptable level for acid value; 4 mgKOH/g [35]. The

low acid value corresponds to a low free fatty acid content, which simply means that the oil has nutritional significance. Peroxide value of *A. paniculata* seed oil (17.57 meq O₂/kg) was higher than the standard range of 2-10 meq/kg given in literature for fresh oil [35]. Likewise, the value was not in agreement with that of Cote d'Ivoire species: 3.43meq/kg [8]; the oil seemed unstable to oxidative degradation. Iodine value is a measure of the degree of unsaturated organic compound, which indicates the reactivity of the double bond. It determines the stability of oils to oxidation and allows the overall unsaturation of the fat to be determined qualitatively. Iodine value of *A. paniculata* seed oil (42.24 mgI₂/100g oil) did not fall within the range of FAO/WHO standard (80-106 mgI₂/100g oil). The

saponification value of oil serves as an important parameter in determining the suitability of the oil for soap making. Saponification value of *A. paniculata* seed oil 203.76 mgKOH/g oil signifies a low molecular weight fatty acid; the oil might find application in soap making industry.

Phytochemical screening of *A. paniculata* seed oil

Qualitative and quantitative phytochemical analysis which plays a significant role in the study of medicinal properties plants for the confirmation of secondary metabolites was carried out on the seed oil of *A. paniculata*. The presence of various phytoconstituents like saponins, anthraquinone, terpenoids, steroids, and alkaloids was noticed whereas there was none for tannins, cardiac glycosides and phenol (Table 5). Saponins are known for their formation of stable foam in aqueous solution, antimicrobial activity inhibitory property against mould and plant's defence system [36]. Other characteristics of saponins are haemolytic activity, cholesterol binding properties [37] and bitterness [38]. The percentage of saponins in *A. paniculata* seed oil was highest (6.25 %) followed by terpenoids (6.10 %) whereas alkaloids were present in only minute quantity (Table 6). The presence of saponins suggest its usefulness in soap making and therapeutically for anticancer and hypolipidemic activity. Alkaloids have been a prominent class of defence compounds among the secondary metabolites [39]. Their presence in the seed oil of *A. paniculata* suggests its application in pharmaceuticals as well as anaesthetics, narcotics, analgesics and central nervous system (CNS) stimulants [40].

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4. W. Caggiula and V. A. Mustad (1997). Effects of dietary fat and fatty acids on coronary artery disease risk and total and lipoprotein cholesterol concentrations: Epidemiologic studies. Terpenoids functions as phytoalexins [41]. *A. paniculata* seed oil terpenoids may find their usefulness in pharmacological activities such as anti-malaria, anti-ulcer etc. [42, 43]. Steroids have antibacterial properties and are important with their relationship with other compounds such as sex hormones [44]. Anthraquinones are largely applied in dye industry [45] as pesticide and additive in chemical alkaline pulp industry.

CONCLUSION

Afraegle paniculata seeds have good nutritional profile with high level of oil, protein, dietary fibre, minerals, and other nutrients comparable with that of other common legumes. The high percentage of *A. paniculata* seed oil affords its consideration as being economical for commercial production of vegetable oil in Nigeria. In the light of the explored nutritional facts, the oil has a potential of serving as a basis for the development of products in the cosmetics, pharmaceutical and food industries. The results also provide reference information for variety of *Afraegle paniculata* and other plants of Rutaceae family found in West Africa.

ACKNOWLEDGEMENT

The authors acknowledge the Department of Chemical Sciences, Faculty of Natural Sciences, Ajayi Crowther University, Oyo and Departments of Chemistry and Microbiology, Faculty of Science, University of Ibadan, Ibadan, Nigeria for their facilities.

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