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Extraction and physicochemical characterization of oil and proximate composition of *Poga oleosa* seeds

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ABSTRACT

The proximate composition analysis using the standard method of analysis of the A.O.A.C (1979) showed that *Poga oleosa* seeds contain the following: moisture (9.20 ± 0.13); ash (2.30 ± 0.02); Protein (16.80 ± 0.09); fat (21.20 ± 0.09); fibre (3.30 ± 0.009) and carbohydrate (56.40 ± 0.00). The physicochemical properties of the essential oil after extraction estimated the physical properties as follows: lipid colour (golden yellow); percentage lipid content (21.20 ±0.09); heat of combustion (46± 0.28); refraction Index (1.45078 ± 0.00); relative density (0.80 ± 0.09); smoke point (125.3 ± 0.27˚C); boiling point (140.6 ± 0.54˚C) and flash point (180.6 ±0.54˚C). The oil had chemical properties with values as follows: acid value (2.97± 0.09), iodine value (158.8± 0.09), saponification value (204.8± 0.18), ester value (201.8 ± 0.09), peroxide value (3.45 ± 0.02), percentage free fatty acid (1.49391 ± 0.0) and saponification equivalent (273.95 ± 0.25).

INTRODUCTION

Every plant species besides its nutritional composition produces some quantity of oil or fat during its life cycle. However only relatively few plants produce fat or oil in sufficient quantity to become articles of commerce. The most important oil plants include castor, sorghum, groundnut, millet; soybean etc, most of these seeds cannot be classified as oil seeds due to the low concentration of oil in them. Oil seeds are seeds which have oil content of 10% and above (Eka, 1997).

The industrial demand for oil seeds has increased tremendously overtime. Vegetable oils are subdivided into four categories: drying oil; semi drying oil; non drying oil and vegetable oils based on their uses ranging from the manufacture of paints, varnishes, lubricants, as food etc (Robbeelen *et al*, 1989). Oil seeds also supply the needs of industries for the manufacture of soaps, cosmetics, and pharmaceuticals. Soybean accounts for more than 50% of the world's oil seed output while sunflower seed and rapeseed account for 19%. The most important oil seeds are the coconut (copra), palm kernels and groundnuts. They contribute about 11% of the world's oil production (Gerhard, 1989).

Due to the ever increasing demand and utilization of vegetable oils for local consumption, in industries, as well as for export, also with the increasing knowledge of dietary fats, it is desirable to improve the range and availability of edible oils with desirable characteristics (Gunstone *et al*, 1986).

The main objective of this study was to determine the proximate composition of *Poga oleosa* seeds and physicochemical characterization of its essential oil.

Poga oleosa is a member of the family rhizophoraceae. The trees are distributed from Nigeria to Congo region in the dense equatorial forest often along river banks and coastlands. It has other common names such as Iku (Yoruba); Imono or Ukwa (Ibos); Inoi or Inoye (Efik and Ekoi); Enyu (Ogoja). In the Cameroun, it is called Ngali (Yaoundé); Pobo or Po'vo (Nungo and Duala). In Gabon, it is called Afo, Mpoga or Poga where the generic name is derived. The tree reaches a height of about 150 ft and has a trunk diameter of upto 4ft (USDA, 2006).

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The tree branches glabrously, purplish leaves elliptic and rounded at the base, obtuse and oblique at apex 12-15cm long, 6-7cm broad, leathery, lateral nerves numerous, petiole flat above 2cm long. Flowers are very small, arranged in panicles of catkin-like spikes on leafless shoots, 4-8 stamens inferior ovary. Ovules are four celled solitary in each cell, fruit is a large drupe, ellipsoid with fleshy exocarp and woody endocarp with numerous resinous lacunae. Seeds are without endosperm and yield oil (Burkill, 1997).

The fruit changes its dark green colour to pale green when fully ripe before it falls to the ground. The colour changes to dark brown when the hard mesocarp becomes succulent producing an unpleasant odour, at this point the seeds can be extracted.

METHODS

The fruits of *Poga oleosa* were collected from Igbo Imabana in Abi local government area of Cross River State. After 14 days, the seeds were removed from the hard shell of the fruits which were now rotten. Seeds were washed and sun dried for 3 days. The seeds were ground into powder. The meal was then subjected to the proximate composition analysis. Using the standard methods laid down by the Association of Analytical Chemists (AOAC, 1979) the moisture content, ash content, crude protein, crude fat, crude fiber and carbohydrate contents were determined. For physicochemical characterization of the oil, lipid extraction of the oil was done using the soxhlet extraction set. The following values were determined:
Acid value (Divine and Williams, 1961); Iodine value (Tewfik *et al*, 1998); saponification value (AOAC, 1979); peroxidase value (AOAC, 1979); ester value was obtained as a difference between the saponification value and the acid value (Williams, 1950); heat of combustion was expressed as the difference between the iodine value and the saponification value (Bailey, 1979); the refractive index was obtained from a relationship between iodine value, saponification value and acid value (Bailey, 1979); percentage free fatty acid was obtained using the formular % free fatty acid = 0.503 x acid value (Gunstone *et al*, 1986); the saponification equivalent was obtained by dividing 56108 by the saponification value of the oil (Anonymous, 2000); the boiling point, smoke point and flash point were determined by heating the oil in a crucible in which a thermometer was inserted. The temperature at which the oil began to boil was recorded as its boiling point. The temperature at which the oil started producing wisps of smoke was recorded as its smoke point while the temperature at which the oil was spontaneous ignited was recorded as its flash point (Gaman and Sherrington, 1989). The relative density of the oil was obtained as the ratio of the volume of the oil to that of an equal volume of water (Hendrikse and Harwood, 1986). Result for each value was determined using mean standard error and analyzed using completely randomized design (CRD).

RESULTS

The results obtained from the proximate composition of *Poga oleosa* seeds and the physicochemical characterization of its oil are presented in tables 1-4 below.

Table 1. Proximate composition of Poga *oleosa* seeds

sample	moisture	ash	protein	fat	fibre	carbohydrate
Poga oleosa seeds	9.20c ±0.13	2.30a ± 0.02	16.8d ±0.09	21.20e ± 0.09	3.30b ± 0.009	56.40f ± 0.0

The values were expressed as g/100g dry wt; X ± SE
The means were highly significant ($p < 0.001$), since the means do not follow with same case letter in the array. F-Ratio= 44217.16, 5%= 3.11, 1%=5.06, 0.1%= 8.89.

Characterization of oil and proximate composition of *Poga oleosa* seeds

Table 2. Chemical properties of *Poga oleosa* oil

Parameters	Values (X ± SE)
Acid value	2.97a ± 0.09
Iodine value	158.8a ± 0.09
Saponification value	204.8a ± 0.18
Ester value	201.8a ± 0.27
Peroxidase value	3.45a ± 0.02
Percentage free fatty acid value	1.49 ± 0.34
Saponification equivalent	269.08a ± 0.25

The values were not significant at 5% =2.55, 1%=4.46 and 0.1%=7.44 level of significance. F-ratio = 2.50

Table 3. Physical Properties of Poga *oleosa* oil.

Parameters	Values (X±SE)
Heat of combustion	46b ± 0.28
Refractive index	1.45073a ± 0.0
Relative density	0.80a ± 0.009
Smoke point (˚C)	125.3c ± 0.27
Flash point (˚C)	180.6e ± 0.54
Boiling point (˚C)	140.6d ± 0.54

The values are significant at 5% =3.11, 1% = 5.06, 0.1% =8.89 levels of significance, F-ratio= 32106.4

Table 4. A comparison of the proximate composition of some world oil seeds and *Poga oleosa seeds* obtained in this study

Oil Seeds	Soy Beans	Cotton Seed	Pea Nut	Sunflower Seed	Rape Seeds	Lin Seed	Safflower Seed	Sesame Seed	Corn	Castor	Palm Kernel	Coconut	*Poga oleosa (Inoi)*
Crude fibre	*3.0*	*11.0*	*11.1*	*10.8*	*10.9*	*8.9*	*8.5*	*5.5*	*15.3*	*11.5*	*14.5*	*11.3*	*3.30*
Ash	*5.9*	*6.5*	*4.5*	*7.7*	*6.3*	*5.6*	*6.4*	*7.3*	*3.5*	*7.5*	*4.6*	*6.6*	*2.30*
Moisture	*10.9*	*8.6*	*7.5*	*7.0*	*9.0*	*8.9*	*11.5*	*7.8*	*8.3*	*13.3*	*9.7*	*7.3*	*9.20*
Protein	*48.5*	*41.6*	*47.4*	*46.8*	*38.5*	*35.9*	*16.0*	*40.0*	*10.4*	*26.0*	*17.4*	*20.7*	*16.8*
Fat(oil)	*18.5*	*19*	*35*	*22.2*	*19.2*	*16*	*30.0*	*34*	*4*	*40*	*44*	*65*	*21.20*
Carbohydrate	*23.2*	*13.3*	*4.3*	*5.5*	*16.1*	*24.7*	*27.6*	*5.1*	*58.5*	-	*9.8*	-	*56.40*

DISCUSSION

Huge financial resources are being used in the importation of processed food products, oils and its finished products inclusive. But nature still has numerous trees that bear quality fruits and seeds whose nutritive content needs to be studied and if found to be highly nutritious could be cultivated in large quantities to subsidize the food and oil needs of our local community. This study attempts to determine the proximate composition of *Poga oleosa* seeds and chemical and physical characterization of its essential oil.

From Table 1, the seeds had a moisture content of 9.20 ± 0.13. This value is comparable with other world oil seeds like linseed (8.9), rape seed (9.0) and palm kernel (9.7) in table 4. The moisture content depends on the drying condition of the sample and does not affect the nutritional status of the seeds under study. The ash content was 2.30 ± 0.02. In comparison with other oil seeds, this value was the lowest which ranged from corn (3.5) to sunflower (7.7). Achinewhu, 1984 that low ash content indicated a poor source of some mineral elements.

Poga oleosa seeds had a fiber content of 3.30 ± 0.009 which is similar to that of soybean (3.0) though the value is low. Following the benefits of fiber intake, consumption of *Poga oleosa* seeds needs to be supplemented with fiber rich food sources to eliminate the risk of bowel diseases as reported by McIntosh *et al*, (2003). The seeds had an oil content of 21.20 ± 0.9 and this qualifies it as an oil seed (Eka, 1997). The protein content was 16.80 ± 0.09. This value is similar with safflower (16.0) and palm kernel (17.4) in table 4. It had a carbohydrate content of 56.40 ± 0.0 which is similar to the carbohydrate content for corn but exceeds the values of other world seeds. This value is an indication that *Poga oleosa* seeds are a high energy giving food source.

The results obtained for the chemical characterization of the oil table 2, 3 indicated acid value to be 2.97 ± 0.9 which is similar to value of castor oil (2-3). This low value indicates the suitability of this oil for paint production but it is not suitable for soap making (Divine and Williams, 1961). The value also indicates that the oil did not undergo oxidative rancidity that is changing odour to an unpleasant smell before use. The seeds had an iodine value of 158.8 ± 0.09. This high value qualifies it as a drying oil alongside linseed oil (165-204) and tungseed oil (160-175). This oil also could be regarded as a substitute for diesel fuel known as biodiesel, used for the production of varnishes, lubricants and ink (Anonymous; Seth, 2003). The saponification value was found to be 204.8 ± 0.18. This high value results from the high molecular weight fatty acids present in the oil. The saponification equivalent was 269.08 ± 0.25 indicating the presence of high molecular weight fatty acids. It determines the amount of potassium hydroxide required to convert a gram of fat into soap. The ester value confirms the fact that the oil will be nutritious, edible oil. The ester value for *Poga oleosa* seeds was 201.8 ± 0.27. The percentage free fatty acid value was 1.49 ± 0.34. According to Fuller (1974), deodorization lowers free fatty acids value. This implies that oil can be stored for long without the incidence of oxidative rancidity. It had a peroxidase value of 3.45 ± 0.02 indicating low oxygen content.

The physical characterization of the oil (Table 3) showed that *Poga oleosa* oil had a refractive index of 1.445078 ± 0.00; this value is not different from the values obtained from world oil seeds ranging from coconut oil (1.4493) to castor oil (1.477). Since refractive index depends on density (i.e. concentration of matter permit volume), the oil can be said to be in moderate composition of matter (saturated and unsaturated). The lipid colour was observed to be golden yellow. It had a heat of combustion value of 46 ± 0.28. Compare with the values of *Telfaria occidentalis* (41.8), *Trichosanthes cucumerina* (32.8) and *Ricinodendron heudelotti* (12.9), *Poga oleosa* oil has a high heat of combustion. This value qualifies the oil for high temperature operations like drying since the oil would be thermally stable (Gaman and Sherrington, 1989).

The relative density was 0.60 ± 0.01; this value indicates the presence of fatty acid and glycerides of high molecular weight. This also suggests that the oil would have increased viscosity, making it suitable for the production of lubricants. The oil has a smoke point of 125.3˚C ± 0.27, boiling point of 140.6˚C ± 0.54 and a flash point of 180.6˚C ± 0.54. These values are relatively low. Impurities such as free fatty acids tend to lower the smoke point from as high as 221˚C to as low as 160˚C (Tewfik *et al*, 1998)

CONCLUSION

These results obtained from *Poga oleosa* in this study showed that the oilseed was not inferior to the familiar edible oil seeds used for domestic and industrial purposes. As such exploitation of the oil seed reserve of this plant would be an economically viable venture, commercial production of oil from these plant seeds would reduce the nation’s dependence on imported oils thereby conserving some of the much needed foreign exchange.

There is need to cultivate such oil plants in large estates. With the applications of modern biotechnological tools to improve yield and quality of oil crops, such ventures will contribute immensely to the agricultural sector of our economy.

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