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The Proximate Composition, Mineral Element Contents and Physicochemical Properties of the Flower Oil of *Aspilia africana* (Pers.) C. D. Adams (Asteraceae)

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ABSTRACT

In a region like Africa and in an era where oil adulteration is commonplace coupled with prohibiting high cost of the available commercial oils, there is need to research for more sources of the commercial oils where quality can be guaranteed and the supplies regular. The flower oil of *Aspilia africana* which can be cheaply extracted from the flowering plant found in abundance everywhere in tropical Africa can solve this problem if its quality compares favourably with the available commercial oils. This work was undertaken to investigate the physicochemical properties of the oil extracted from the flower of *Aspilia africana* with the view of comparing its quality with some commercial vegetable oils and exploring its potentials as pharmaceutical base oil. The proximate composition, mineral element contents, physicochemical properties and the fatty acid composition of the flower oil obtained by soxhlet extraction using n-hexane were determined using standard methods and the results compared with those of some standard commercial oils. The physicochemical analysis gave comparable values of some parameters such as relative density, refractive index, optical rotation, viscosity, acid value, ester value, hydroxyl value and iodine value with those of some commercial vegetable oil. The GC-MS analysis showed the oil to contain high levels of unsaturated fatty acids (oleic acid, 59.07%). Proximate analysis of the oil showed that it contained 36.40% of carbohydrate, 22.35% of protein, 8.90% ash and 15.6% lipid. Iron and potassium had the highest concentrations as mineral elements. The characteristic properties of this oil suggested potential for its application as pharmaceutical oil that might satisfy some of the deficiencies of commercial vegetable oils.

Keywords: *Aspilia africana,* peroxide value, oleic acid, acid value, oil adulteration, flower oil.

INTRODUCTION

The problem of oil adulteration has been a trending phenomenon in Nigeria and generally in tropical Africa. This coupled with prohibiting high cost of the available commercial oils has created a need for search for more sources of the commercial oils where quality and regular supplies can be assured. *Aspilia africana* (Pers) C. D. Adams because of its availability and potentials can readily become a solution to this problem. *Aspilia africana* is an important member of Asteraceae family. It is a tropical weed with deep yellow flowers that can grow up to about 1.5 m long. The plant has many therapeutic uses in different traditional medicines all over the world. Different parts of the plant are used for different medicinal treatments. The plant is used to treat malarial fever and microbial infections; expel worms and relieve pains; secure abortion and remedy gastro intestinal disorders among others (Nwachukwu *et al*., 2010; Oko *et al*., 2011; Ogunwande *et al*., 2012). Various biological activities such as anticoagulant, anti-inflammatory and anti-malarial have been attributed to the plant and its extracts (Iwu, 1993, Agonihatre *et al*., 2010). The unique aspect of the plant is its survival everywhere in tropical Africa. The plant grows luxuriantly and abundantly everywhere in this region without any pastoral care. The leaves have been reported to provide a quality grade of oil that compares favourably with existing vegetable oil in the market (Obuzor and Nkom, 2010). It was a fantastic discovery that the soxhlet extraction of the dried flower part of the plant yielded pure oil which analysis to determine its quality was the focus of this research. The research was conducted to characterize the oil based on its physicochemical properties, proximate composition, mineral elements and fatty acid contents. The results were compared with those of the existing oils used as pharmaceutical base oil. The work was also established the level of the purity of the oil compared to other vegetable oils already in the market. It should be recalled that the purity of edible oils is of utmost importance because it is a risk factor that affects consumer's health (Shubham, 2018).

Therefore it was necessary to authenticate its purity by evaluating the physicochemical properties.

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The purity of vegetable and edible oils is generally ascertained using saponification value, iodine value, acid value, density, refractive index, viscosity as well as other parameters used in this research work (Azadmard-Damirchil and Torbati, 2015). This research work has brought to limelight the potentials of flower oil of *Aspilia africana* as possessing a quality suitable for use in pharmaceutical drugs and as a good substitute of many commonly available vegetable oils. This in effect will also reduce adulteration of vegetable oils in this area, as it can be sourced cheaply. Until now a full characterization of the oil produced from the flower of *Aspilia africana* has not been reported.

MATERIALS AND METHODS

Place and Time

This research work carried out in Department of Pharmaceutical and Medicinal Chemistry Research Laboratory, University of Uyo, Nigeria, between March 2018 and June 2018.

Collection, Identification and Extraction of the Plant Material

The fresh plant material was collected in Zaria, Northern Nigeria and identified as previously reported (Johnson *et al*., 2016). The flower was sorted, graded, dried under shade and pulverized using a mortar and pestle before extraction. The pulverized flower material (500 g) was extracted with n-hexane using soxhlet method. The extract was evaporated to dryness *in-vacuo* to remove the solvent; weighed and then stored in a refrigerator for subsequent use. The extract was obtained as yellow oil.

Physical Evaluation of the oil

Some physical properties of the oil sample were determined. Refractive index was determined using Abbe Refractometer (V.I A-IS digital); optical rotation by Automatic polarimeter (Techmel, China) using a wavelength of sodium D line, 589 nm; relative density with relative density bottle (10 ml), viscosity using Oswald viscometer as described by British Pharmacopeia (1993) and translucency by spraying the oil on a white sheet of paper.

Chemical evaluation of the n-hexane oil

Tests were carried out to determine the saponification, acid, iodine, ester and peroxide values as well as unsaponifiable matter in the n-hexane oil using standard methods (Olaniyi and Ogungbamila, 1998; Vlab.Amrita.edu, 2011; AOCS, 2000).

Proximate analysis

Moisture, ash, crude protein, crude lipid, dietary fibre and available carbohydrate (by difference) analyses were done using the methods described by (AOAC, 2007). Energy content was estimated in kcal/100 g by the Atwater general factors system - multiplying the percentages of available carbohydrate, crude protein and crude lipid by 4, 4, and 9 respectively (Hassan *et al*., 2011).

Mineral Elements Analysis

Analysis of mineral elements was carried out after digestion of 1 g of the sample with 12 cm^3 mixture of nitric/perchloric/sulphuric acids in the ratio of 9:2:1 respectively. Sodium, zinc, potassium, iron, copper, calcium, lead, sulphur , cobalt, phosphorus, chlorine and cadmium were analyzed using Atomic absorption spectrophotometer with the appropriate lambs (ASTM, 2014)

Determination of the Fatty Acid Composition

The n-hexane oil (2 g) was refluxed with KOH (1M) in 95% ethanol (40 ml) for 2 h; HCl (10%, 10 mL) was added to the cooled solution and extracted exhaustively with n-hexane-diethyl ether (1:1 v/v; 3 x 20 mL). The organic extract was washed with water, dried over anhydrous Na_2SO_4 (William and Han, 2010). The analysis of the organic extract was carried out using Gas Chromatography-Mass Spectrometry (GC-MS). The GC-MS analysis was done using Shimadzu QP2010 plus series gas chromatography coupled with Shimadzu QP2010 plus mass spectroscopy detector (GC-MS) system. The fatty acids peaks were identified by comparing their retention times with those of the standards and NIST05 mass spectral library (NIST, 2014). The concentrations of the component fatty acids were calculated as a percentage of the peak area to the total area of all the fatty acids in the sample.

Statistical analysis

All quantitative observations and measurements were average of three consistent values and are reported with their standard deviation. Paired samples t-test was used to compare test parameters with control using the SPSS 16 software. Significance of any effect of test against the respective control standards were tested at 95% confidence level ($p \leq 0.05$).

RESULTS

The oil was obtained as light yellow liquid with carroty smell (45 g; 9 %) which showed a persistent translucency when sprayed on paper indicating oil.

The results of the physicochemical properties of the oil measured, mineral element composition, proximate analysis and fatty acids composition were presented in tables 1, 2, 3 and 4 respectively.

Physicochemical Properties of the oil

Table 1 shows the results of the determination of the physicochemical properties of the flower oil of *Aspilia africana* compared with those of common vegetable oils commonly used as pharmaceutical base oils.

Table 1: Physico-chemical properties of *Aspilia africana* flower extract compared with some other vegetable oils.

Properties (mg/g)	Flower oil of Aspilia *africana*	Arachis (peanut oil) B.P	Olive virgin oil	Moringa oleifera	Sunflower
Oil content (%)	45 g (9%)		30%	38%	35%
Relative density (@25ºC)	0.910 ±0.20	0.915	0.909 - 0.915	0.900	0.915 – 0.919
Refractive index	1.55±0.12	1.468	1.472 ± 0.002	1.457±0.002	1.4610
Optical rotation	1.224 ±0.32	1.463	-	-	-
Viscosity (mPa.s) @25ºC	63.31 ±3.62	98.92	56.2±0.3	49.96 ±0.2	48.8 ±0.2
Acid value mgKOH/g of oil	1.122 ±0.20	0.448	6.6	-	2-6
Ester value (mgKOH/g of oil)	42.00 ± 2.25	33.66	-	-	-
Hydroxyl value (mgKOH/g of oil)	29.172 ±3.11	4.995	-	-	8-12
Iodine Value (g I/100g)	69.54 ±4.21	86 - 107	80.01± 0.7	-	78 - 90
Saponification (mgKOH/g of oil)	196.35 ±1.22	190.00	188 ± 4.99	189.66	188-193
Peroxide value (meq/kg of oil)	11.5±0.56	Max 5	20	-	1.07
Unsaponifiable matter (%)	0.6 ±0.16	≤ 10	≤ 15	-	≤ 15

(-) = Data not available

Mineral Elements Composition

The result of mineral elements analysis of flower Oil of A, africana is presented in table 2

Table 2: Mineral Elements Content

Mineral Elements	Concentration (ppm)
Lead	<0.0010
Copper	2.1341
Cobalt	0.3456
Iron	190.1323
Zinc	1.1326
Cadmium	0.0216
Calcium	2.4505
Sodium	71.8708
Potassium	114.3210
Phosphorus	0.0124
Chlorine	1.8220
Sulphur	0.0321

Proximate Composition

The result of proximate analysis of Flower oil of *A. africana* is presented in table 3

Table 3: Proximate Composition

Composition	% Composition
Moisture	6.37
Ash	8.90
Carbohydrate	36.40
Fibre	17.29
Lipid	15.06
Protein	22.35
Energy Value (kcal/100g)	370.54

Fatty Acid Composition of Flower Oil of *Aspilia africana*

Table 4: Fatty Acids content of flower oil of *Aspilia africana*

Peak	Compound	Retention time (mins)	Mol form.	% composition
1	Palmitic acid (C16:0)	18.047	$C_{16}H_{33}O_2$	21.00
2	Oleic acid (C18:1)	20.936	$C_{18}H_{34}O_2$	59.07
3	Stearic acid (C18:0)	21.140	$C_{I8}H_{36}O_2$	10.59
4	Linolenic acid (C18:3)	21.768	$C_{18}H_{28}O_2$	2.88
5.	Linoleic acid (C18:2)	22.459	$C_{18}H_{32}O_2$	0.92
6	Arachidic acid (C20:0)	24.267	$C_{20}H_{40}O_2$	1.10
7.	Behenic acid (C22:0)	24.614	$C_{22}H_{44}O_2$	3.52
8	Erucic Acid (C22:1)	26.321	$C_{22}H_{42}O_2$	0.92

DISCUSSION

The quality of any oil is indicated by the physico-chemical properties. The specific values of some of these properties provide an indication of both the nutritive and physical quality of the oil. These properties were determined for the oil in this research work as shown in tables 1- 4. The density, viscosity and refractive index of the flower oil were comparable with the standard range approved by the Standard Organization of Nigeria (Standard Organisation Nigeria, (SON) 2000,) and those of commercial vegetable oils. Acid, saponification, iodine, and peroxide values determined for flower oil of *Aspilia africana* were lower than those of other commercial oils including *Aspilia africana* leaf oil (Obuzor and Nkom, 2010) and edible palm oils as specified by SON, 2000 and Nigerian Industrial Standards (NIS), 1992). This implies that the oil may have a longer storage time and higher quality than the commonly known commercial oils. Fatty acid composition has a significant influence on nutritional and medicinal properties of oils. The relative fatty acid composition of the flower oil of *Aspilia africana* is presented in Table 2. Eight fatty acids were found in quantifiable amounts. The type of fatty acids found in the flower oil is almost the same as reported for the leaf by Obuzor and Nkom (2010), differing only in quantities and degree of saturation. The fatty acids found in the oil included the monounsaturated fatty acids (MUFAs) specifically oleic acid (59.07%) and Erucic Acid (0.92 %). Oleic acid is considered to be responsible for lowering the low density lipid (LDL, otherwise referred to as bad lipid) cholesterol levels.

The polyunsaturated fatty acids (PUFAs) found in the oil included; linoleic acid and uracic acid. These acids have been found to have beneficial effects on both normal health and chronic diseases, such as regulation of lipid levels and cardiovascular and immune-functions (Mori *et al*., 2000). Saturated fatty acids found in the oil included, Palmitic, stearic, behenic, docoanoic and arachidic acids which can be used to produce soaps, cosmetics, industrial mold release agents, lubricant, hardener and emulsifier.

Proximate analysis of flower oil of *A. africana* indicated a high carbohydrate content while ash, moisture, fibre and protein were equally found in reasonable quantities. The caloric value was calculated as 399.6 kcal/100 g. The mineral content analysis of the flower oil (Table 2) showed that iron was the predominant element followed by potassium. Iron is a constituent of haemoglobin in the red blood cells. It is also found in other enzyme forms in all animals. Deficiency of iron leads to hypochromic anemia (USDA, 2012). Other mineral present included; calcium, magnesium, sodium, copper, zinc, chlorine, sulphur and phosphorus while the toxic minerals like lead, cobalt and cadmium were found in trace amounts. Potassium is a very important mineral for the proper functioning of all cells, tissues and organs in the body (Anac and Martin-Prevel, 1999). Sodium is an essential nutrient that regulates blood volume, blood pressure, osmotic equilibrium and pH (Davidson *et al*., 1975). Calcium is an important component of a healthy diet and a mineral necessary for the formation of supporting tissues in the body. It also plays a very important role in the development of stronger and denser bones and teeth early in life and maintains the strong and healthy bones and teeth later in life (Obuzor and Nkom, 2010). Copper is an antioxidant as well as a regulator of gene expression. It has an intrinsic ability to kill a variety of potentially harmful pathogens in the human body (Heaney and Weaver, 1990).

CONCLUSION

Analysis of the flower oil *Aspilia Africana*, (a weed that grows luxuriantly without any pastoral care everywhere around tropical Africa usually ignored and used as fodder by grazing goats) showed it contained essential food ingredients, useful mineral elements, essential fatty acids including the monounsaturated (MUFAs) and polyunsaturated fatty acids (PUFAs) like oleic, linoleic (an omega-6) and linolenic fatty acids as the combined major constituents. The physicochemical indicators of the oil showed that, it is suitable to be used in pharmaceutical drugs formulations and can satisfy some of the deficiencies of commercial virgin olive oil and a few other vegetable oils.

SIGNIFICANCE STATEMENT

This study discovered that the flower oil of *Aspilia africana* is of high quality and compared favourably with existing commercial vegetable oils including those used in pharmaceutical drug formulations and can be beneficial as a substitute for some vegetable oils. This study will provide a basis for further studies by researchers to uncover the critical properties of the flower oil such as phytonutrients composition e.g. carotenoids, sterols and vitamins constituents that are yet to be explored.

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