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THE ESSENTIAL OIL COMPONENTS OF *IRVINGIA GABONENSIS AND IRVINGIA WOMBOLU* FROM SOUTHERN NIGERIA

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ABSTRACT

The chemical composition of volatile compounds from seeds of *Irvingia gabonensis* and *Irvingia wombolu* (Irvingiaceae) grown in Southern Nigeria has been studied. Essential oils from two species of the plant were obtained by solvent extraction in conventional Clavenger- like apparatus. The major compounds in these essential oils were identified using gas chromatography-mass spectrometry GC and GC/MS. Twelve and ten components were identified in *I. gabonensis* and *I. wombolu* , respectively, of which carboxylic acids and esters were the major components in both species. The oils obtained from the two species have been profiled by GC/MS to obtain data and they showed similarities but also differences in their composition. Fatty acids and esters compounds were the most abundant components in the oils. The present study may represent the first of its kind on the characterization of the volatile constituents in *Irvingia* species and useful contribution to the better understanding of interspecies relationships in this genus.

Keywords: Essential oil, *Irvingia gabonensis*, *Irvingia wombolu*, chemical constituent

INTRODUCTION

The tropical rainforest zone is rich in medicinal plants possessing array of potential medicinal properties but the Phyto-pharmaceuticals and ethno-medicinal values have not been fully utilized (Baladrin *et al*., 1993; Stephen *et al.*, 2009; Oladosu *et al.*, 2011). These potential benefits are due not only to the species richness of the tropical flora, but also to the parasites and pathogens which the plants must provide some level of defensive mechanism. Many of these defense phytochemicals secreted (such as alkaloids, tannins, saponins) can be used as remedies against diseases and infections in humans, and also to eradicate other organisms (Farnsworth, 1988, Falodun *et al.*, 2009; Falodun, 2010; Naresh *et al.*, 2011; Adisa *et al.*, 2011). Essential oils form one of the numerous pharmacologically active metabolites in plants, and they are widely used as medicines in the form of medicaments, pharmaceuticals and food additives (Reische *et al*., 1998; Cowan, 1999; Onwuliri *et al.*, 2004, Gehan *et al.*, 2008; Quang *et al*., 2011).

Irvingia gabonensis also known as wild mango is a forest fruit tree widely available in Africa (Eka, 1980). *Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill. and *I. wombolu* Vermoesen (family Irvingiaceae) are the two species of the genus in Nigeria (Harris, 1996). The pulp surrounding the fibrous-coated, hard-shelled nut of *I. gabonensis* is sweet and edible when ripe while that of *I.wombolu* is bitter and inedible. The nuts of both species, also known as dika nuts, are widely used in Nigeria as a soup thickener because they gelatinize into a thick, viscous sauce base for vegetable soup when heated (Onyeike *et al*., 1995). Though these thickening properties are due to the carbohydrate content of the kernel (Ndjouenkeu *et al.*, 1996; Okolo, 2000), fat represents its main component (51–72 %), with a fatty acid profile mainly made up of myristic acid (33–50 %) and lauric acid (38–58%) (Leakey, 1999; Leakey *et al*., 2005). Some potential industrial applications of the dika nut oil that have been identified include its usefulness in the preparation of margarine, cooking oil, soap, and perfumery, and as a lubricant in tablet formulations (Abaelu and Akinrimisi, 1980; Udeala and Onyeachi, 1980; Osagie and Odutuga, 1986).

Of the Non-timber forest products (NTFPs) *Irvingia* is one of the indigenous fruit trees with multiple uses and generates a high cash income within and outside Nigeria (Okafor, 1985; Okafor, 1991; Ladipo and Boland, 1994; Akubor, 1996; Ladipo, 1999). Its kernels are highly priced as soup condiments (Okafor, 1985; Okeke, 1995). The pulp of *I. gabonensis* is used for the preparation of juice, jelly and jam; while the extracted fat from both varieties is used in soap making, pharmaceutical preparations and domestic use (Okafor, 1985). Ejiofor *et al*. (1987) reported the composition of *I. gabonensis* var *excelsa* (now *I. wombolu*) as 51.3% fat, 26.0% total carbohydrate, 2.5% ash, 7.4% crude protein, 0.9% crude fibre, 9.2mg 100-1 vitamin C and 0.6mg 100-1 vitamin A. Proximate analysis of the nutritive composition of healthy kernels of *I. gabonensis* and *I. wombolu* obtained from

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retailers showed significant differences in some nutritive components (Ikhatua *et al.,* 2010). Values obtained were 9.2 and 9.7% crude protein; 2.1 and 2.3 % ash; 97.8 and 97.8% organic matter; 9.8 and 8.6% crude fibre; 39.7 and 38.4% fat, and 39.2 and 41.0% carbohydrate respectively. In contrast to numerous papers reporting about the ethnomedicinal and Pharmaceutical uses of *I. gabonensis* and *I. wombolu* secondary metabolites, particularly fatty acids, as well as their anti-obsesity and other possible applications in phyto-therapy, we observed a relative paucity of data on the essential oil composition of the plants. To the best of our knowledge, there are no published reports on the essential oil composition of seeds from *I. gabonensis* and *I. wombolu.*

The aim of this study therefore, was to explore and determine whether there are differences in the essential oil composition of the two species or not, using GC and GC/MS analyses.

MATERIALS AND METHODS

Plant collection and identification

Fruits of *Irvingia gabonensis* and *Irvingia wombolu* were obtained from standing trees in Ujabhole-Irrua in Esan Central Local Government Area of Edo State, Nigeria during the harvest season of 2010. These were processed for their stones (endocarp with the seeds within) dried, and cracked to obtain the kernels (seeds).

Extraction and isolation of essential oil

The powdered *Irvingia gabonensis* and *Irvingia wombolu* were extracted by Clevenger like apparatus for 3hours, to give yellow color oil. The oil was subjected to filteration and drying using an anhydrous sodium sulphate. The sample was stored in a refrigerator at -4°C before running in GC and GC-MS analysis.

Identification of the components

The chemical principles of the essential oil from the GC - MS analysis were identified by simple comparative analysis of their retention indices and mass spectra with those already reported (Adams, 1989, 2001; BP, 1980; Julian and Konig, 1989).

Gas Chromatography

The oil obtained from the extraction was subjected to GC and GC-MS respectively in order to obtained qualitative and quantitative data. A Shimadzu GC-17A system, furnished with an AOC-20i auto sampler and split/splitless injector was used for the analysis. A DB-5 column having 30m, 0.25mm i.d, 0.25µm df coated with 5% diphenyl-95% polydimethylsiloxane, conditioned to an oven temperature of 50^{o}C (1minute), 3^{o}C/minute to 250^{o}C (5 minutes), 2^{o}C/minute to 280^{o}C. The carrier gas, nitrogen at 30 cm/s linear velocity and inlet pressure 99.8KPa; temperature of detection 280^{o}C, flow rate 50 ml/minute, while the air flow rate of 400ml/min, make-up (H_2/air), 50ml/min, sampling rate, 40ms were used. Acquisitions of quantitative and qualitative data were obtained by Shimadzu GC solution software.

Gas chromatography-mass spectrometry analysis

The carrier gas (helium) composition was made of agilent 6890N interfaced with a VG 70-250s double focusing mass spectrometer. The operating conditions of the Mass spectrometer include ion source 250^{o}C electron voltage at 70 eV. The GC was had DB-5 column. Similar operating parameters to those of GC (previously described) were used.

RESULTS AND DISCUSSION

The solvent extraction of *I. gabonensis* and *I. wombolu* seed part yielded light yellow oil. The identity of the constituents, their retention indices on a DB-5 column, and their percentage composition are listed in tables 1and 2, where the compounds are arranged in order of their GC elution on the DB-5 capillary column. GC and GC–MS analysis enabled the identification of a total of 12 and 10 constituents, representing 99.0 and 93.0% of the total oils, respectively.

In *I. gabonensis* oil, dodecanoic acid (50.7%), tetradecanoic acid (30.5%) and octadecanoic acid (8.6%) were found to be the major constituents; all the other components were detected at concentrations below 5% of the total oil. Carboxylic acids (94.9%), esters (5.7%) and ketones (0.9%) were the main groups of constituents of the essential oil. The oil of *I. wombolu* had esters consisting mainly of dodecanoate (2.9%), tetradecanoic acid (50.7%), oleic acid (12.5%) and hexadecanoic acid (7.5%) as major chemical principles. Aldehydes and ketones were completely absent. The presence of (*Z, Z)*-9,12-octadecadienoic acid in *I. wombolu* is noteworthy because this acid, considered an essential fatty acid, is the precursor of prostaglandins PG1 and PG2 (Carmen *et al*., 2008). Esters were found to be copious in both species of *Irvingia* as shown by the identified components. Esters are known to be formed mainly at the stage of ripening of fruit, and they are also important for the sweet and fruity aroma of most fruits (Dimick and Horkin, 1983). It could be broadly inferred that the characteristic aroma of the *Irvingia* species could be attributed to the heterocyclic compounds and the organic acids.

On comparing our results of *I. gabonensis* oil with *I. wombolu* oil compositions, it was observed that out of 12 and 10 constituents present in the above oils, respectively, seven constituents were common to both oils. It was also observed that the fatty acid composition in *I. gabonensis* and *I.wombolu* were 94.9 and 89.2% respectively which is in agreement with published data of (Ekpo *et al*., 2007).

Table 1. Volatile oil composition of seeds of *I. gabonensis* from GC-MS analysis.

Peak	Components	RI	Content (%)
1	Methyl tetradecanoate	1002	0.2
2	Dodecanoic acid methyl ester	1056	0.5
3	Dodecanoate propyl ester	1101	0.3
4	Dodecanoic acid	1205	50.7
5	Octanoic acid ester	1209	1.5
6	Undecanone	1283	0.9
7	Decanoic acid	1365	0.4
8	Dodecanoate ethane ester	1390	0.5
9	Hexadecanoic acid	1767	4.7
10	Tetradecanoic acid	1769	30.5
11	Octadecanoic acid	1984	8.6
12	cis-Linoleic acid methyl ester	2091	2.2
		Total	99.0

Table 2. Volatile oil composition of seeds of *I. wombolu* from GC/MS analysis.

Peak	Components	RI	Content (%)
1	Methyl tetradecanoate	1002	0.5
2	Dodecanoic acid methyl ester	1056	2.9
4	Dodecanoic acid	1205	59.0
5	Hexadecanoic acid	1767	7.5
6	Tetradecanoic acid	1769	7.6
7	Octadecanoic acid	1858	2.1
8	Oleic acid	1958	12.5
9	(Z,Z)-9,12-octadecadienoic acid	2225	0.5
10	Dodecanoate propyl ester	-	0.5
		Total	93.0

The identification was performed by calculation of retention index (RI) on a DB-5-; BP.

Future research will focus on the biological and pharmacological investigations of the essential oils of both species.

CONCLUSION

From the above results it is evident that there is slight variation in the percentage composition of the volatile oils of *I. gabonensis* and *I. wombolu* major constituents, which could be indicative of different biosynthetic and biogenetic pathways since both are agro climatically and geographically related.

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