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GC/MS characterization of volatile components of hydrocolloids from *Irvingia gabonensis* and *Mucuna sloanei* seeds

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A B S T R A C T

Irvingia gabonensis and *Mucuna sloanei* seeds are among the known soup thickeners used in the preparation of different kinds of soups and local delicacies in Southeast Nigeria. The thickening substances which are hydrocolloids have been isolated and partially characterized using gas chromatography-mass spectrometry method. Eighteen constituents were identified in *I. gabonensis* comprising aromatic (0.76 %), hydrocarbons (7.19 %), ketones (1.53 %), carboxylic/fatty acids (79.47 %) and esters (11.04 %). Twenty-one constituents were identified in *M. sloanei* comprising hydrocarbons (22.58 %), esters (19.42 %), fatty acids (45.64 %), amide (5.77 %), aldehyde (4.69 %) and ketones (1.89 %). This research reveals that the seed hydrocolloids of *M. sloanei* contain more volatile phytochemicals than that of *I. gabonensis*.

Capsule Summary: *Irvingia gabonensis* and *Mucuna sloanei* seeds were characterized and the major constituents were aromatics, hydrocarbons, ketones, carboxylic/fatty acids and esters along with other minor constituents.

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INTRODUCTION

Food gums have been reported to possess certain pharmacological and nutritional benefits to man (Viebke et al., 2014). Interestingly, most of the plant materials (if not all) used in Southeast Nigeria as food thickeners, stabilizers and emulsifiers possess these gums known as hydrocolloids. Regrettably, most of these plants are underutilized, except as food gums. *Irvengia gabonensis* and *Mucuna sloanei* belong to such plants. The seed flours of these two plants are rich in hydrocolloids (Ndjouenken et al., 1996; Wanjekeche et al., 2003), no wonder they are used as soup thickeners among other things.

I. gabonensis belongs to the family *Simarubaceae* (Ayivor et al., 2011). The plant grows straight, up to a height of 40 m (130 ft) and 1 m (3 ft 3 in) in diameter. It has buttresses to a height of 3 m (9.8 ft) (Anegbeh et al., 2003). The fruits are yellowish when ripe, broadly ellipsoid and variable in size between varieties, 5-7.5 cm with a yellow, fibrous pulp surrounding a large seed (Orwa et al., 2009). The common names of *I. gabonensis* include wild mango, African bush mango, sweet bush mango, bread tree and dika fruit (Ekpe et al., 2007; Ogunsina et al., 2012).

It is traditionally known as 'ogbono' in Southeast Nigeria. *I. gabonensis* is indigenous to Africa and is found mostly around the humid forest zone from the northern tip of Angola, including Congo, DR Congo, Nigeria, Côte d'Ivoire, Ghana, Equatorial Guinea, Gabon and south-western Uganda (Anegbeh et al., 2003). The plant is used in traditional herbal medicine to relief diarrhoea and dysentery. It is used internally as a purgative, for gastrointestinal and liver conditions, for sterility, hernias and urethral discharge, and is considered to be a powerful aphrodisiac (Orwa et al., 2009). Fruit pulp is palatable and can be used for a fruit drink and for jam production. The kernel can be processed into flour by extraction, drying and grinding. The pounded seed is added to meat and various vegetable dishes as a sauce. Margarine and cooking oil can be obtained from the kernels (Orwa et al., 2009). The seeds constitute very important soup condiment used in thickening and flavouring soups in Nigeria. Its high nutritional and socio-economic potential makes it stand-out amongst other food crops in Nigeria (Onyeike et al., 1995; Ogunbusola et al., 2014). It is the food gum component of the seeds that serves as a thickening agent in water (especially hot water) (Ndjouenken et al., 1996).

M. sloanei belongs to the family *Papilionaceae*. It is very widespread, in Africa from Sierra Leone east to DR Congo, and south to Angola, also in the Caribbean region, tropical America and islands of the Pacific Ocean (Jasen, 2005). Most of the *Mucuna* species are herbaceous twining plant. They possess trifoliate leaves unequal at base. Flowers are white to dark purple in colour and hang in long clusters. Pods are sigmoid, turgid and longitudinally ribbed. Seeds are ovoid black or white. *Mucuna* pods are covered with reddish orange hairs which are readily dislodged (Gurumoorthi et al., 2003; Natarajan et al., 2012). *M. sloanei* is cooked for pregnant women to avoid miscarriages. The blood sugar lowering effect of the gum from *M. sloanei* has been reported. The seeds are widely used in Nigeria for the management of diabetes mellitus (Okwu and Okoro, 2007). Many species of *Mucuna* seeds have been reported to be used in the treatment of leucorrhoea and spermatorrhoea (Nadkarni, 1982; Natarajan et al., 2012). The seeds possess anabolic, androgenic, analgesic, anti-inflammatory, antispasmodic, antivenom, aphrodisiac, febrifuge, cholesterol lowering, hypoglycemic, immunomodulator, antilithiatic, antibacterial, antiparasitic, cough suppressant, blood purifier, carminative, hypotensive, and uterine stimulant properties (Sridhar and Rajeev, 2007; Natarajan et al., 2012). *M. sloanei* seed is used in Southeast Nigeria as condiment. The powder may be used as recipes in some food items and in beverages (Wanjekeche et al., 2003). A black dye is obtained from all parts of *M. sloanei*, which is used in Nigeria to dye fibre and leather black. Oil extracted from the seed can be used in the preparation of resin, paint, polish, wood varnish, skin cream and liquid soap (Jasen, 2005).

There is paucity of information on the analysis of gums (hydrocolloids) isolated from the seed flour of *I. gabonensis* and *M. sloanei*. However, considering the enormous economic, nutritional and health importance of these two plants to south-easterners in Nigeria, we report herein the GC/MS characterization of volatile components of hydrocolloids from *Irvingia gabonensis* and *Mucuna sloanei* seeds.

MATERIAL AND METHODS

Sample collection and preparation

The *I. gabonensis* and *M. sloanei* seeds were bought at Ubani Market in Umuahia, Abia State, and each was identified in the Forestry Department of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Clean endosperms of the seeds were dry-milled using a laboratory manually driven milling machine and the milled samples were passed through a 500 µm sieve.

Extraction of hydrocolloids

Hydrocolloids were extracted from the seed endosperm flours of *I. gabonensis* and *M. sloanei* by employing the method described by Igwe and Nwokocha (2014). In a typical extraction procedure, 10 g of sample was dispersed in 250 ml distilled water and hydrated continuously by means of a stirrer for 2 h. This was poured into centrifuge tubes and centrifuged at 2500 rpm for 30 min. The supernatant was poured into a large beaker. The residue was reconstituted repeatedly with fresh distilled water, stirred and centrifuged again. The supernatant was pooled together and treated with isopropanol, when the hydrocolloids spooled out; the clear liquor was decanted while the trapped solvent was removed by filtration. The crude hydrocolloids were re-precipitated with isopropanol. The hydrocolloid sample was dried in a convention oven at 60 °C overnight and cooled in desiccators. This was pulverized using a blender and stored in a sealed container.

Gas chromatography/mass spectrometry analysis

GC analysis was carried out in Shimadzu Japan gas chromatography 5890-11 with a fused GC column (OV-101) coated with polymethyl silicon (0.25 mm × 50 m) and the conditions were as follows: temperature programming from 80–280 °C held at 80 °C for 1 min., at 200 °C for 4 min. (rate10 °C/min), and finally at 280 °C for 5 min. (rate 10 °C/min). The injection temperature was 250 °C. GC/MS analysis was conducted using GCMS-QP 2010 Plus (Shimadzu, Japan) with column oven temperature of 80 °C. The carrier gas was helium with a pressure of 108.2 Kpa. All solvents used were of analytical grade and were procured from Merck, Germany. The components of the extract were identified by matching the peaks with computer Wiley MS libraries and confirmed by comparing mass spectra of the peaks and those from literature as well as using the database of National Institute of Standards and Technology (NIST) (Igwe and Okwu, 2013).

RESULTS AND DISCUSSION

GC/MS analysis

Eighteen volatile phytochemical constituents were identified in the seed hydrocolloids of *I. gabonensis* as shown in the chromatogram of Fig. 1. The retention time and percentage composition of each of these compounds are shown in Table 1.

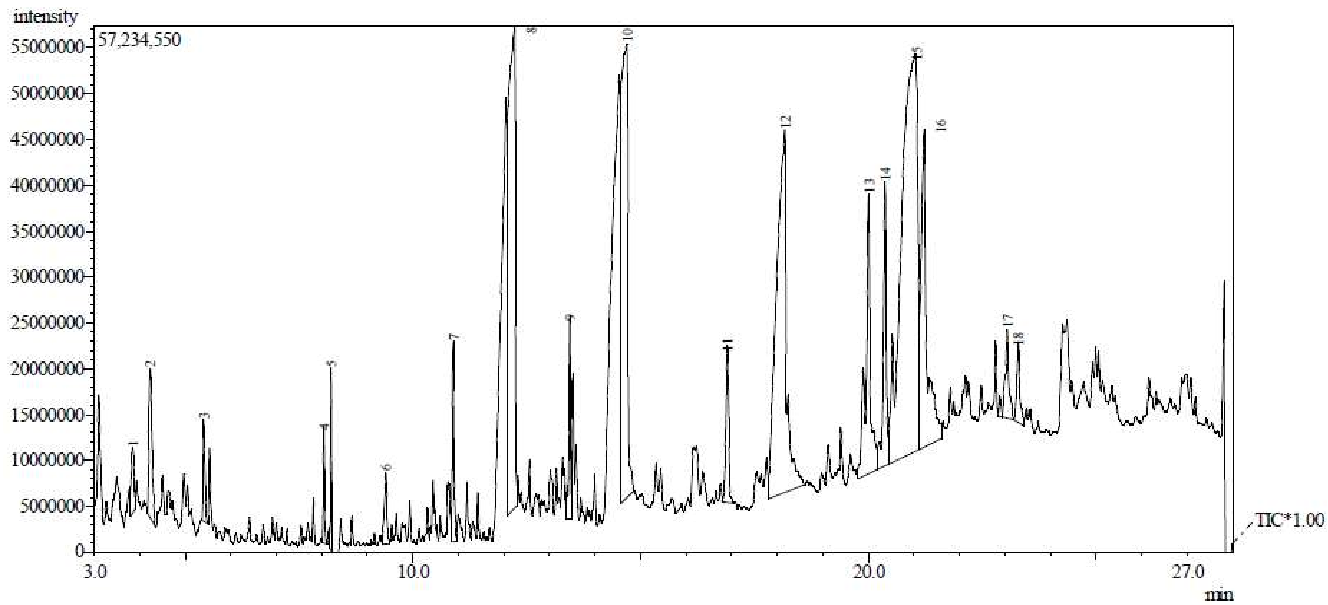

Fig. 1: GC/MS chromatogram of *I. gabonensis* seed hydrocolloids

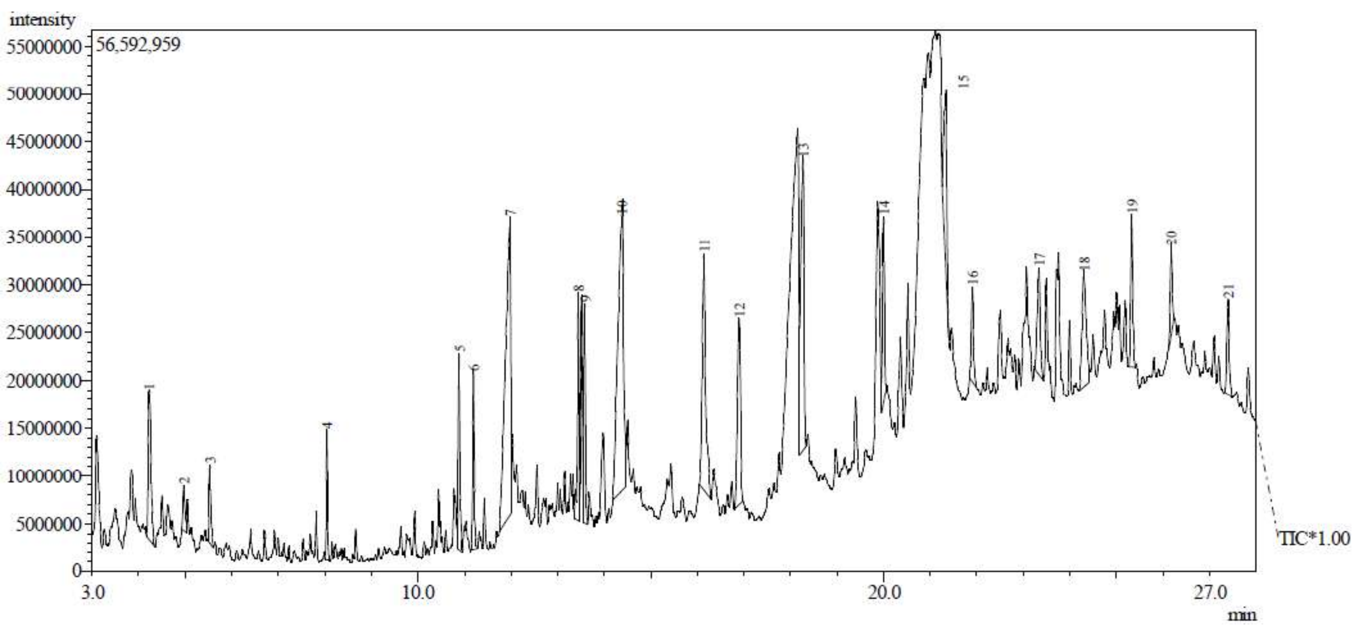

Fig. 2: GC/MS chromatogram of *M. sloanei* seed hydrocolloids

The compounds consist of aromatic (0.76 %), hydrocarbons (7.19 %), ketones (1.53 %), carboxylic/fatty acids (79.47 %) and esters (11.04 %). Fatty acids constitute the bulk of the volatile constituents of hydrocolloids from *I. gabonensis* with 9-octadecenoic acid (oleic acid) as the most abundant compound with 27.93 % composition followed by hexadecanoic acid (palmitic acid) with 16.02 % composition. The next abundant class of compounds is the esters. *I. gabonensis* seed flour produces a characteristic sweet smell when used to prepare soup in Southeast Nigeria. This characteristic smell could be due to the presence of esters since esters are sweet-smelling class of compounds.

In the same vein, twenty-one phytochemicals were identified in the seed hydrocolloids of *M. sloanei* as shown in the chromatogram of Figure 2. Table 2 shows the retention time and percentage composition of each of these compounds. These compounds consist of hydrocarbons (22.58 %), esters (19.42 %), fatty acids (45.64 %), amide (5.77 %), aldehyde (4.69 %) and ketones (1.89 %).

Fatty acids are seen to be the major constituents of the volatile constituents of the hydrocolloids from *M. sloanei* with hexadecanoic acid and dodecanoic acid as the prominent fatty acids present with compositions of 15.77 and 15.57 % respectively.

Table 1: Volatile phytochemicals from *I. gabonensis* seed hydrocolloids

Peak no	Components	Retention time(min)	Percentage composition (%)
1	1,2,3-Trimethylbenzene	3.848	0.76
2	Decane	4.229	1.91
3	2-Nanonone	5.410	0.78
4	4,7-dimethyl undecane	8.045	0.67
5	2-Undecanone	8.205	0.75
6	Decanoic acid	9.410	0.81
7	Tetradecane	10.880	1.58
8	Dodecanoic acid	12.229	13.75
9	Octadecane	13.445	1.52
10	Tetradecanoic acid	14.865	12.34
11	Hexadecanoic acid methyl ester	16.902	2.00
12	Hexadecanoic acid	18.164	16.02
13	11-Octadecanoic acid, methyl ester	20.009	5.51
14	Octadecanoic acid methyl ester	20.372	3.53
15	9-Octadecenoic acid	21.031	27.93
16	Octadecanoic acid	21.219	7.60
17	11-(1-ethylpropyl) heneicosane	23.052	1.51
18	Docosanoic acid	23.298	1.02

Table 2: Volatile phytochemicals from *M. sloanei* seed hydrocolloids

Peak no	Components	Retention time(min)	Percentage composition (%)
1	Decane	4.232	4.35
2	5-Methyldecane	4.967	0.93
3	Undecane	5.536	1.25
4	2-Methylundecane	8.047	1.67
5	2,3-Dimethyldodecane	10.883	3.06
6	Tridecanoic acid methyl ester	11.196	2.73
7	Dodecanoic acid	11.979	15.57
8	Octadecane	13.443	3.54
9	Tetradecanoic acid methyl ester	13.581	3.40
10	Hexadecanoic acid	14.390	15.77
11	1-(ethenyloxy) Octadecane	16.139	7.78
12	16-Hexadecanoyl hydrazide	16.894	5.77
13	Hexadecanoic acid ethyl ester	18.272	9.15
14	11-Octadecanoic acid methyl ester	20.002	3.69
15	2(2-hydroxyethoxy)ethyl ester octadecanoic acid	21.338	4.49
16	3-Methyl butyl ester	21.906	1.95
17	Eicosanoic acid	23.338	2.94
18	7,11-Hexadecadienal	24.293	4.69
19	Heptadecanioc acid ethyl ester	25.326	3.18
20	7-Octadecanone	26.173	1.89
21	Ethyldocosanoate	27.395	2.19

Fatty acids play an important role in various physiological functions and contribute to many health effects (Kulkarni and Fernando, 2015). *M. sloanei* also contain a high level of esters. Little wonder *M. sloanei* flour gives out a characteristic appetizing smell when used in preparing traditional soups and delicacies.

The volatile phytochemicals analysed in the hydrocolloid extracts of *I. gabonensis* and *M. sloanei* might possess physiological and pharmacological properties. From these observations, the seed hydrocolloids of *M. sloanei* contain more volatile phytochemicals than that of *I. gabonensis*. There is indeed paucity of documented information on the volatile constituents of hydrocolloids form *I. gabonensis* and *M. sloanei* thereby making comparison of results obtained here with results obtained by other researchers (Chandanasree et al., 2016; Ferrero, 2017; Gannasin et al., 2016; Gyawali and Ibrahim, 2016; Li and Nie, 2016; Lopez-Rubio et al., 2016; Rosa-Sibakov et al., 2016).

CONCLUSIONS

The volatile hydrocolloid constituents of *I. gabonensis* and *M. sloanei* seeds were analysed using GC/MS method. The analyses showed that fatty acids were the bulk constituents of the two seeds and that *M. sloanei* was found to contain more volatile constituents than *I. gabonensis*. It is a known fact that hydrocolloids mostly consist of starch molecules. However, this investigation provides information on the basic constituents of the volatile part of hydrocolloids obtained from the seeds of *I. gabonensis* and *M. sloanei*.

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