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Constituent of Essential Oil from *Ficus benghalensis* L.

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Authors' contributions

This work was carried out in collaboration between all authors. Authors MAA collected the plant while SOA performed the distillation of essential oil and carried out the GC/MS analysis. Author IAO designed the study, managed the literature searches and wrote the draft of the manuscript. Both authors OIE and AAA also managed some section of the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The characterization of the leaf essential oil of *Ficus benghalensis* L. (Moraceae) was performed by gas chromatography-flame ionisation detector (GC-FID) and gas chromatography-mass spectrometry (GC-MS). Monoterpene compounds (5.9%) are less common in the oil while the sesquiterpene compounds accounted for 85.8% of the total oil content. The main constituents of the oil were the sesquiterpenes α-cadinol (25.1%), germacrene-D-4-ol (14.9%), γ-cadinene (11.8%) and α-muurolene (9.6%). This is the first report on the volatile constituents of *F. benghalensis*.
Aims: To report the compounds identified in the hydrodistilled leaf oil of *Ficus benghalensis* grown in Nigeria.
Study Design: The design of the study involved the distillation of essential oil from air-dried leaf of *F. benghalensis* and subsequent analysis of the constituents.

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Place and Duration of Study: Leaf sample of *F. benghalensis* were collected from Omileye area, Ore Town, Odigbo Local Government, Ondo State, Nigeria, in March 2013.
Methodology: The air-dried and pulverized leaf of *F. benghalensis* was subjected to hydro distillation using a Clevenger-type apparatus for 4 h. The constituents of the distilled oil were analyzed by using GC and GC/MS.
Results: The main constituents of the oil were the sesquiterpene α-cadinol (25.1%), germacrene-D-4-ol (14.9%), γ-cadinene (11.8%) and α-muurolene (9.6%).
Conclusion: Although, this is the first report on the volatile constituents of *F. benghalensis,* the observed compositional pattern was found to vary from data obtained from previously analyzed oils from other member of the genus *Ficus* grown in Nigeria.

Keywords: Ficus benghalensis; Moraceae; essential oil composition; sesquiterpenes; α-cadinol; germacrene-D-4-ol; γ-cadinene.

1. INTRODUCTION

There are more than 800 species and 2000 varieties of *Ficus*, most of which are native to the old world tropics. *Ficus benghalensis* L. (family: Moraceae) is native to a wide area of tropics [1]. This plant is astringent to bowels and useful in treatment of biliousness, ulcers, vomiting, vaginal complains, fever, inflammations and leprosy. Pharmacologically various extracts of *Ficus benghalensis* has shown anti-rheumatic [1], antioxidant [1,2], hepatoprotective [3], antibacterial [4,5], larvicidal [6,7], anthelmintic [8], wound healing [9,10], anti-stress, antiallergic [11], anti-inflammatory, analgesic [12,13] and immunomodulatory [14] activities. The plant has been assessed for its anti-arthritic [15], antimutagenic [16] and antidiabetic [17] potentials. A methanolic extract of *F. benghalensis* protects against oxidative liver injury in rats [18]. Reviews on the pharmacological potentials of *F. benghalensis* have been published [19,20].

The bark of *F. bengalensis* yields 5,7-dimethyl ether of leucopelargonidin-3-0-α-L rhamnoside and 5,3- dimethyl ether of leucocynidin 3-0-α-D-galactosyl cellobioside, β-glucoside, 20-tetratriaconthene-2-one, 6- heptatriacontene-10 one, pentatriacontan-5-one, beta sitosterol-alpha-Dglucose and meso-inositol [12,21-24]. Leucodelphinidin derivative [25], bengalenoside [26], leucopelargonin, a glycoside which has antidiabetic effects and leucocynidin derivative have also been isolated from the bark of the *F. bengalensis* [27,28]. Three ketones 20-tetratriacontene-2-one, 6- heptatriacontene-10-one and pentatriacontan-5-one [29] as well as genistein [30] were isolated from stem bark. The seed oil was found to contained vernolic acid (8.2%), malvalic acid (3.7%) and sterculic acid (1.6%) along with the other normal fatty acids like lauric acid (1.5%), myristic acid (1.3%), palmitic acid (35.2%), stearic acid (4.2%), oleic acid (20.3%), linoleic acid (15.4%) and linolenic acid (8.7%) [31]. The presence of gallic acid, rhein, gallocatechin and theaflavin-3, 3'-digallate were reported from the methanolic extract of *F. benghalensis* [32].

However, information revealed the composition of essential oil of this plant has not been the subject of literature report. Therefore, the aim of the present study is to analyze and report for the first time the chemical compounds identified in the essential oil of *F. benghalensis*. The chemical constituents of essential oils from Nigeria plants [33] in general and *Ficus* species [34-36] in particular have been documented

2. MATERIALS AND METHODS

2.1 Plant Collection

Mature leaves of *F. benghalensis* were collected from plants growing at a location in Omileye area, Ore, Odigbo Local Government, Ondo State, Nigeria, in March 2013. Botanical identification was carried out at Forestry Research Institute of Nigeria (FRIN), Ibadan, where a voucher specimen (FHI 109903) was deposited. Plant samples were air-dried prior to extraction.

2.2 Distillation of Essential Oil

Aliquots of 200 g of air-dried and pulverized leaves were subjected to hydrodistillation for 4 h at normal pressure in a glass Clevenger-type apparatus according to the British Pharmacopoeia specifications [37]. The yield of essential oil was 1.07% (v/w), calculated on a dry weight basis. Oil sample was light yellow in coloration.

2.3 Analysis of Essential Oil

The composition of the essential oils was determined by gas chromatography-mass spectrometry (GC/MS) using an Agilent 7890N GC with Agilent mass detector Triple Quad 7000A in EI mode at 70 eV (m/z range 40- 600 amu) and an Agilent Chem Station data system. The GC column was equipped with an HP-5MS column (30 m x 250 µm x 0.25 µm film thickness) a split-split less injector heated at 200ºC and a flame ionization detector (FID) at 230ºC. The oven temperature was programmed as follows: Initial temperature 40ºC for 5 min, increased 5ºC/min to 180ºC for 6 min and then 10ºC/min to 280ºC for 12 min. Helium was the carrier gas at flow rate of 1 mL/min. The injection volume was 2.0 µL (split ratio 1:20).

The relative amount of each individual component of the essential oil was expressed as the percentage of the peak area relative to the total peak area. RI value of each component was determined relative to the retention times of a homologous *n*-alkane series with linear interpolation on the HP-5MS column.

2.4 Identification of the Components

The components were identified by comparison of their mass spectra with NIST 1998 library data of the GC-MS system as well as by comparison of their retention indices (RI) with the relevant literature data [38,39].

3. RESULTS AND DISCUSSION

Table 1 displayed the identities and percentage compositions of compounds present in the leaf oil of *F. benghalensis*. A total of twenty-four compounds representing 96.4% of the total contents were identified in the oil. Sesquiterpenes (31.7% hydrocarbons and 54.1% oxygenated) represents the prominent class of compounds in the essential oil. Monoterpenes (6.9%) are less common in the oil. The main constituents of the oil were the sesquiterpenes α-cadinol (25.1%), germacrene-D-4-ol (14.9%), γ-cadinene (11.8%) and α-muurolene (9.6%). There are sizeable amounts of β-caryophyllene epoxide (6.2%), α-copaene (4.7%), cubenol (4.1%) and τ-cadinol (3.8%). This is the first report on the volatile constituents of *F. benghalensis*.

However, the chemical constituents of essential oils from some other *Ficus* plants grown in Nigeria have been reported. A previous study revealed that 1, 8-cineole (13.8%), (*E*)-phytol (13.7%) and p-cymene (11.4%) were the significant compounds of the leaf oil of *F. exasperata* [34]. In another study, β-caryophyllene (37.0%) and ethyl octanoate (13.9%) were the representative compounds of the oil of *F. mucosa* [35]. The main compounds identified in the leaf oil of *F. elastica* [36] were 6,10,14-trimethyl-2-pentadecanone (25.9%) and geranyl acetone (9.9%). The main compounds in *F. lutea* were acorenone B (20.7%) and phytol (16.2%) while *F. polita* had phytol (23.3%) and 6, 10, 14-trimethyl-2-pentadecanone (15.0%) in abundance, with *F. thonningii* comprising mainly of 6, 10, 14-trimethyl-2-pentadecanone (18.8%) and phytol (14.7%) [40].

The leaf oil of *F. benjamina* [41] collected during the day contained high contents of α-pinene (13.9%), abietadiene (9.7%), *cis*-α-bisabolene (8.2%) and germacrene-D-4-ol (8.4%), while the night sample was dominated by germacrene-D-4-ol (31.5%), 1,10-di-*epi*-cubenol (8.8%) and hexahydrofarnesyl acetone (8.3%). The main constituents of *F. capensis* [42] were α-cadinol (10.6%), α-pinene (9.3%) and α-humulene (6.5%). While (*E*)-phytol (24.5%) and hexadecanoic acid (10.0%) constitute the main compounds of *F. ovata*, *F. elasticoidies* comprised mainly of (*E*)-phytol (20.9%) and 6, 10, 14-trimethyl-2-pentadecanone with the main components of *F. natalensis* subsp. *leprieurii* being (*E*)-phytol (37.6%) and 6, 10, 14-trimethyl-2-pentadecanone (24.9%) [43].

It could be seen that the main constituents of previous studies on the essential oil of *Ficus* plants from Nigeria such as α-pinene, *p*-cymene, 1, 8-cineole, acorenone B, (*E*)-phytol, 6, 10, 14-trimethyl-2-pentadecanone, hexadecanoic acid, ethyl octanoate, tricosane, hexacosane and cyclcotetradecane were not identified in the *F. benghalensis*. The variation in the compositional pattern of essential oil of *F. benghalensis* and other *Ficus* oils grown in Nigeria may be attributed to the nature and chemotype of the plants being studied as well as varying climatic and ecological conditions in the place of collection.

It is well known that the biological activities of an essential oil may depend on the major constituents or a synergy between the major and some minor compounds. Referring to literature, some constituents of essential oil of *F. benghalensis* such as linalool, (E)-α-Ionone (E)-.

Table 1. Chemical constituents of essential oil of *F. benghalensis*

Compounds	RI (Cal.)	RI (Lit.)	Percent (%)
Toluene	794	790	1.7
n-Hexanal	806	800	0.4
Ethylbenzene	863	868	1.1
α-Phellandrene	1004	1002	1.0
Limonene	1028	1024	0.3
Linalool	1085	1095	1.0
n-Nonanal	1104	1100	0.5
β-Cyclocitral	1204	1217	0.3
Cyclosativene	1360	1383	4.7
α-Copaene	1374	1373	1.0
β-Maaliene	1412	1413	0.7
β-Caryophyllene	1419	1417	0.8
(*E*)-α-Ionone	1429	1422	0.3
Geranylacetone	1460	1458	1.8
γ-Muurolene	1475	1477	1.1
(*E*)-β-Ionone	1485	1490	2.2
α-Muurolene	1499	1500	9.6
γ-Cadinene	1511	1513	11.8
δ-Cadinene	1525	1522	2.0
Germacrene D-4-ol	1574	1571	14.9
β-Caryophyllene epoxide	1582	1589	6.2
τ-Cadinol	1639	1640	3.8
Cubenol	1643	1650	4.1
α-Cadinol	1650	1663	25.1
Total			**96.4**
Monoterpene hydrocarbons			**1.3**
Oxygenated monoterpenes			**5.6**
Sesquiterpene hydrocarbons			**31.7**
Oxygenated sesquiterpenes			**54.1**
Non-terpenes			**3.7**

β-Ionone and β-caryophyllene have shown antimicrobial potentials, larvicidal and insecticidal activity against some insect pest [1]. This may have contributed to the observed biological potentials of *F. benghalensis.*

4. CONCLUSION

For the first time, the chemical constituents of essential oil of *F. benghalensis* grown in Nigeria are being described. From this report, major differences were observed between the oil compositions of *F. benghalensis* in this study and previous studies on other *Ficus* plants. This may be attributed to differences in the ecological and climatic conditions between the points of collection as well as the age and nature of the plant, handling procedure etc.

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CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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