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RESEARCH ARTICLE

Composition of Essential Oil of Nigerian (Niger Delta) Grown *Gardenia Jasminoide* Flower

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ABSTRACT

The essential oil from Gardenia jasminoide flower was obtained by hydrodistillation and analyzed by Gas Chromatography (GC). Fifty-four components were characterized, representing 100% of the total components detected . The oil is composed mainly of sesquiterpenes 49.01% and monoterpene 44.33%. The major constituents of sesquiterpenes were identified as α-Farnesene (28.41%) and small amounts of Guaiol (5.89%), (z)-3-Hexenyl Tilgate (5.47%), Bulnesol (5.03%), cis-3-Hexenly Benzoate (4.21%). In the case of monoterpene, Linalool (22.05%) was the major constituent and trans-β-Ocimene (10.59%), α-Terpineol (9.03%) with Methyl Tiglate (2.66%) as the minor component while Tetracosane (5.64%) was the only alkane.

INTRODUCTION

Nigeria is abundantly endowed with plants of various species and many of them have unutilized economic and medicinal values. Amongst these, are flowering plants such as gardenia which most see only as being decorative. *Gardenia jasminoide* is a small tree which could attain a height of about 3 – 4 meters whose branches are ashen grey in colour with elliptic and acuminate leaves [1]. The flowers are usually solitary although they could occur in pairs; they are terminal but often appear laterally at the nodes by sympodial growth. This species is currently cultivated as a hedge plant in the Urban and villages all over the Niger Delta. Gardenia is a genus of 142 species of flowering plants in the coffee family, Rubiaceae, native to the tropical and subtropical regions of Africa, southern Asia, Australasia and Oceania [2]. In Japan and China, *Gardenia jasminoides* is called **Kuchinashi** (Japanese) and **Zhi zi** (Chinese); the bloom is used as a yellow dye, which is used for clothes and food (including the Korean mung bean jelly called hwangpomuk). In France, Gardenia is the traditional flower which men wear as boutonnieres and it is the national flower of Pakistan.

Essential oil is a mixture of hydrocarbons and organic heterocyclic compounds (secondary metabolites) produced by a plant species. The specific composition is also characteristic of a given species from which the essential oil is distilled usually obtained by steam distillation, whereas 'flower oils' are generally extracted by using fats (a process called "enfleurage" www.encyclopedia.) These oils are highly priced and could be obtained from the leaves, fruit or bark. Essential oil from leaves of *Cotinus coggygria* Scop. (Anacardiaceae) obtained by hydrodistillation was analyzed by GC–MS [3] and forty-two components were characterized, representing 99.6% of the total components detected. The major constituents were identified as limonene (48.5%), (*Z*)-β-ocimene (27.9%) and (*E*)-β-ocimene (9.7%). Agar oil is hydrodistilled from agarwood (*aquilaria malaccensis*) and it's highly prized for its fragrance. Male and female flowers of *V. album* L. growing on different host trees were analysed by solid phase micro-extraction and by lipophilic extraction; α-Farnesene was obtained as the main component of the volatile fraction [4].

The importance of essential oil are numerous and varied. A. *cordifolia* has been used widely throughout Africa to treat such as dermatitis, asthma, hepatits, splenomegaly, vaginitis, metritis and colitis; Aspilia *Africana* (Pers.) C. D. Adams (asteraceae) is commonly referred to as the Hemorrhage plant due to its ability to stop blood flow from wounds and Garcinia *mangostana* Linn. is used as a traditional medicine for the treatment of trauma and skin infection . Some essential oils are used for perfumery and aromatherapy. The fruit of Gardenia *jasminoides* has been included in traditional medicine formulations for the treatment of inflammation. Geniposide, a major iroid glycoside of the

fruit shows inhibition of both 5-lipoxygenase and ovalbumin-induced junction permeability. Here, we report the composition of Niger Delta grown Gardenia *jasminoide* essential oil obtained by hydrodistillation of the flower.

MATERIALS AND METHOD

Plant materials: The Gardenia *jasminoide* flower was obtained from University of Port Harcourt hedge and was duly identified by at the Haberum, Department of Plant Science and Biotechnology, University of Port Harcourt.

Isolation of oil: Essential oil was obtained from 500g of fresh flower petals by hydrodistillation in an all glass Clevenger-type apparatus. The oil was collected over water, dried ($MgSO_4$) and preserved by refrigeration until ready for analysis.

Analysis of oil: Gas Chromatography analysis was accomplished with HP 6890 Powered by HP ChemStation Rev. A 09.01 [1206] Software and HP 5MS capillary columns (30m x 0.25mm x 0.25µm film thickness). The program temperature is 40 ^{0}C per 10min, 5^{0}C/min to 200 ^{0}C. Injector and detector temperature were maintained at 300 ^{0}C; the carrier gas is hydrogen (1.0ml/min), detector dual, FID. Volume injected was 0.5µl. Identification of components was obtained by comparison of their retention time with those of pure authentic samples and by means of their linear retention indices (LRI) relative to the series of n-hydrocarbons.

N. B: Distillation was done at Department of Pure and Industrial Chemistry, University of Port Harcourt, Port Harcourt, Rivers State while gas chromatography (GC) analysis was done at Bello Laboratory, 20 Daniel Makinde Street, Ketu, Lagos.

RESULTS AND DISCUSSION

The analytical results are shown in Table 1 where the components are listed in order of elution. The essential oil of Gardenia *jasminoide* extracted by hydrodistillation shows 32 constituents in trace amounts while minute amounts of sesquiterpenes like germacrene d (0.03%), germacrene b (0.08%), *β*-caryophyllene (0.05%) and calarene (0.14%) with some monoterpenes such as nerol (0.4%), *α*-thujene (0.03%), *cis* – 3 – hexenol (0.22%), myrcene (0.02%), allo – ocimene (0.03%), *α*-pinene (0.02%) and *β*-pinene (0.02%) were also observed (Table 1).

The following six constituents were observed in appreciable amounts in the essential oil. (1) **Methyl tiglate** also known as methyl (E)-2-methylbut-2-enoate, methyl (E)-2-methyl crotonate, methyl (E)-2-methyl-2-butenoate, methyl 2-methyl crotonate, methyl alpha-methyl crotonate, (E)-2-methyl crotonic acid methyl ester, methyl trans-2-methyl crotonate, methyl trans-2-methyl-2-butenoate and tiglic acid methyl ester is a monoterpene and colourless in appearance. Its concentration in our oil is 2.66%. (2) ***cis*-3-Hexenly Benzoate** (4.21%) also known as (Z)-hex-3-enyl benzoate, (Z)-hex-3-enyl] benzoate, (Z)-3-hexen-1-ol benzoate, (Z)-3-hexen-1-yl benzoate, *cis*-3-hexen-1-yl benzoate, (Z)-3-hexenyl benzoate, *cis*-3-hexenyl benzoate is a sesquiterpene and a colourless oily liquid. (3) **Bulnesol** a sesquiterpene alcohol may be acetylated, yielding "guaiyl acetate" which is highly valued in perfumery for its elegant, mild tea-rose-like odor and good fixative properties (http://www.bojensen) was in 5.03% yield for our gardenia. (4) **Z-3-Hexenyl Tilgate** is a sesquiterpene and also known as *cis*-hex-3-ene-1-yl trans-2-methyl-2-butenoate, [(Z)-hex-3-enyl] (Z)-2-methylbut-2-enoate, (Z)-3-hexen-1-yl (E)-2-methyl 2-butenoate, (Z)-3-hexen-1-yl 2-methyl crotonate, *cis*-3-hexen-1-yl 2-methyl crotonate, (Z)-3-hexen-1-yl alpha-methyl crotonate, *cis*-3-hexen-1-yl alpha-methyl crotonate, (Z)-3-hexen-1-yl tiglate, *cis*-3-hexen-1-yl tiglate, *cis*-3-hexen-1-yl trans-2-methyl 2-butenoate, *cis*-3-hexen-1-yl-2-methyl-trans-2-butenoate, (Z)-3-hexenyl (E)-2-methyl 2-butenoate, (Z)-3-hexenyl tiglate, *cis*-3-hexenyl tiglate, *cis*-3-hexenyl trans-2-methyl 2-butenoate, (2E)-2-methyl-2-butenoic acid (3Z)-3-hexen-1-yl ester and (E,Z)-2-methyl-2-butenoic acid 3-hexen-1-yl ester [5] was obtained in 5.47% yield for our sample. (5) **Tetracosane** obtained in 5.64% yield is the only alkane ($C_{24}H_{50}$) observed. (6) **Guaiol** (5.89%) is a sesquiterpene alcohol which like bulnesol may be acetylated, yielding "guaiyl acetate" which is highly valued in perfumery for its elegant, mild tea-rose-like odor and good fixative properties (http://www.bojensen).

α-Terpineol (Fig. 1) is a naturally occurring monoterpene alcohol that has been isolated from a variety of sources such as cajuput oil, pine oil, and petitgrain oil (en. Wikipedia, *α*-Terpineol). There are three isomers, alpha-, beta-, and gamma-terpineol, the last two differing only by the location of the double bond. Terpineol has a pleasant odour similar to lilac and is a common ingredient in perfumes,

cosmetics, and flavours. α-terpineol is one of the two most abundant aroma constituents of lapsang souchong tea; the α-terpineol originates in the pine smoke used to dry the tea [6]. Although it is

Table 1. Chemical composition (%) of the essential oil of **gardenia *jasminoide flower***

S/No	Name	Concentration	Retention time
1.	Benza aldehyde	Trace	5.992
2.	1 – Octen – 3-ol	Trace	6.199
3.	Cymene	Trace	6.350
4.	*α*-Phellandrene	Trace	6.950
5.	*trans-β*-Ocimene	10.59	7.654
6.	Camphene	Trace	7.950
7.	Terpinolene	Trace	8.273
8.	Sabinene	Trace	8.760
9.	Limonene	Trace	9.257
10.	*α*-Pinene	0.02	9.828
11.	*β*-Pinene	0.02	11.219
12.	Benzyl alcohol	Trace	11.454
13.	*Cis* – 3 – Hexenol	0.2	12.913
14.	Myrcene	0.01	12.995
15.	Allo Ocimene	0.03	13.195
16.	*α*-Thujene	0.03	14.213
17.	*γ*-Terpiene	Trace	14.935
18.	Citral	Trace	15.089
19.	Neral	Trace	15.298
20.	Geranial	Trace	15.394
21.	Isoartemisia	Trace	15.455
22.	1, 8-Cineole	Trace	16.540
23.	Borneol	Trace	16.536
24.	Linalool	22.05	17.707
25.	Citronellal	Trace	18.197
26.	Nerol (geraniol)	0.4	18.540
27.	*α*-Terpineol	9.02	18.684
28.	Terpinen-4-ol	Trace	18.782
29.	Citronellol	Trace	19.258
30.	**Methyl tiglate**	**2.66**	**20.124**
31.	Linalyl acetate	Trace	20.802
32.	***(z)*-3-Hexenyl tiglate**	**5.47**	**21.406**
33.	Borneol acetate	Trace	21.614
34.	Neryl acetate	Trace	21.710
35.	Calarene	0.20	21.809
36.	*β*-Bisabolene	Trace	21.915
37.	Germacrene b	0.08	22.078
38.	*β*-Caryophyllene	0.10	22.428
39.	Cyperene	Trace	23.343
40.	Germacrene d	0.03	24.035
41.	*α*-Gurjunene	Trace	24.668
42.	*α*-Copane	Trace	24.785
43.	*β*-Selinene	Trace	26.960
44.	*α*-Bergamotene	Trace	27.080
45.	*α*-Selinene	Trace	28.303
46.	*α*-Bisabolene	Trace	28.376
47.	*β*-Selinene	Trace	28.497
48.	Γ-Murolene	Trace	28.573
49.	Viridiflorol	Trace	28.774
50.	*α*-Farnesene	28.41	29.225
51.	*cis*-3-Hexenyl benzoate	4.21	29.448
52.	Guaiol	5.89	29.496
53.	Bulnesol	5.03	29.788
54.	Tetracosane	5.64	30.269

naturally occurring, terpineol is commonly manufactured from the more readily available α-pinene. The inhibitory effect of terpenes and *S*-farnesylthiosalicylic acid on the biosynthesis of both dolichol and the isoprenic side chain of ubiquinones and the isoprenylation of proteins in the intraerythrocytic stages of *P. falciparum* appears to be specific, because overall protein biosynthesis was not affected [7]. Combinations of some terpenes or *S*-farnesylthiosalicylic acid tested with other antimalaria drugs, like fosmidomycin indicates that they could be a new strategy for the treatment of malaria. In this analysis, the concentration of α-terpineol was 9.03%.

The **ocimenes** refers to several isomeric hydrocarbons and are monoterpenes found within a variety of plants and fruits. *α*-Ocimene and the two *β*-ocimenes differ in the position of the isolated double bond: it is terminal in the alpha isomer and the *α*-Ocimene is 3,7-dimethyl-1,3,7-octatriene while *β*-Ocimene is 3,7-dimethyl-1,3,6-octatriene. *β*-Ocimene was found in plants to be communication signal molecule and it exists in two stereoisomeric forms, *cis* and *trans*, with respect to the central double bond [8] The ocimenes are often found naturally as mixtures of the various forms. The mixture (as well as the pure compounds) is oil with a pleasant odor used in perfumery [9]. *trans-β*-Ocimene concentration in our analysis is 10.59%.

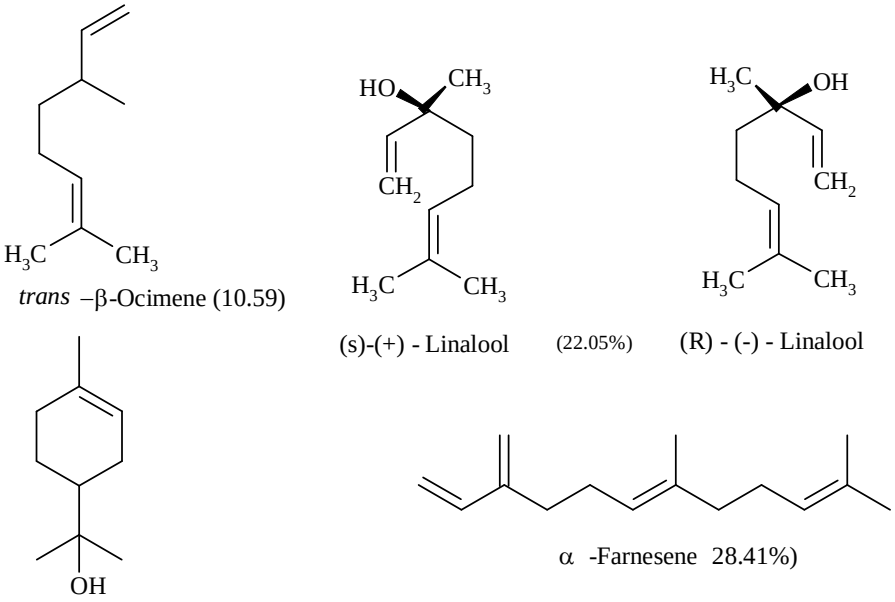

Figure 1. Major essential oil constituents of Gardenia jasminoide flower

Linalool a monoterpene alcohol is one of the major constituent of the essential oil of Gardenia *nitida* with a concentration 22.05% (Table 1, Fig. 1). Linalool is a naturally-occurring chemical found in many flower and spice plants with many commercial applications, the majority of which are based on its pleasant scent (floral, with a touch of spiciness). It has other names such as *β*-linalool, linalyl alcohol, linaloyl oxide, *p*-linalool, allo-ocimenol and 2,6-dimethyl-2,7-octadien-6-ol. Linalool has a stereogenic centre at C_3 and therefore two stereoisomers: **licareol** is (*R*)-(–)-linalool and **coriandrol** is (*S*)-(+)-linalool. Both enantiomeric forms are found in nature: S-linalool is found, for example, as a major constituent of the essential oils of coriander (*Coriandrum sativum* L. family Apiaceae) seed, palmarosa [*Cymbopogon martinii* var martinii (Roxb.) Wats. family Poaceae], and sweet orange (*Citrus sinensis* Osbeck, family Rutaceae) flowers. (R)-Linalool is present in lavender (*Lavandula officinalis* Chaix, family Lamiaceae), laurel (*Laurus nobilis*, family Lauraceae), and sweet basil (*Ocimum basilicum*, family Lamiaceae), among others (http://ezinearticles.com). Linalool appears to kill cancer cells at a very low concentration. The effect of the various coriander seeds oil components (obtained by hydrodistillation) on the viability of different cell lines (HepG2, Caco2, NIH3t3, MCF7 and Hek293) was examined [10]. Linalool was the most potent and HepG2 cells (cells of liver cancer used throughout the world for cancer research) the most sensitive. A 50% and 100% decrease in the

viability of HepG2 was obtained at 0.4µM and 2µM linalool, respectively. It has been observed that linalool has anxiolytic (anti-stress) effects and also breathing of Linalool, extracted from pure essential oils, leads to lowered aggressive actions, lessens stress response, and improves sleep [11].
The term **farnesene** refers to a set of six closely related chemical compounds which all are sesquiterpenes. α-Farnesene and β-farnesene are isomers; *α*-Farnesene is 3,7,11-trimethyl-1,3,6,10-dodecatetraene while *β*-farnesene is 7,11-dimethyl-3-methylene-1,6,10-dodecatriene (http://en, farnesene). The alpha form can exist as four stereoisomers that differ about the geometry of two of its three internal double bonds (the stereoisomers of the third internal double bond are identical). The beta isomer exists as two stereoisomers about the geometry of its central double bond. α-Farnesene is also the chief compound contributing to the scent of gardenia, making up approximately 65% of the headspace constituents [12] and for our sample, *α*-Farnesene is the major constituents of the flower in yield of 28.41% (Table 1, fig. 1). The lack of literature for most essential oils makes comparism in composition difficult.

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