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Aroma Profile of Essential Oils of *Solenostemon monostachyus* P. Beauv from Nigeria

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Abstract

This study was conducted to evaluate the volatile oils constituents of *Solenostemon monostachyus* P. Beauv, an aromatic non-conventional vegetable. The essential oils isolated by hydrodistillation from leaves, stem, floral and aerial parts of *S. monostachyus* (P.Beauv.) Briq. were investigated by gas chromatography-mass spectrometry (GC-MS). A total of fifteen constituents were identified and characterized by the high amount of sesquiterpenoid (43.13-91.21%). The leaf oil comprised mainly of β-caryophyllene (71.42%), α-caryophyllene (7.0%), 1-octen-3-ol (6.96%) and caryophyllene oxide (6.67%); the stem oil consisted of β-caryophyllene (46.75%), α-caryophyllene (20.22%), caryophyllene oxide (10.45%) and 1-octen-3-ol (10.31%); the predominant compounds in the floral oil were 1-octen-3-ol (40.24%), β-caryophyllene (18.94%) and α-caryophyllene (16.98%); while β-caryophyllene (27.43%), caryophyllene oxide (24.83%) and α-caryophyllene (12.9%) were the abundant components of the aerial oil. The chemical composition of *S. monostachyus* essential oils from Nigeria is reported for the first time.

1 Introduction

Volatile oils (also known as essential oils) are concentrated hydrophobic liquid consisting of volatile aroma compounds from plants. Volatile oils utility range from aromatherapy, household cleaning products, personal beauty care, and natural medicine treatments[1]. *Solenostemon monostachyus* P. Beauv (family Lamiaceae) is an essential oil bearing plant, and an important edible herb that is widespread in West and Central Africa. The plant is an erect, branched annual weed with a long inflorescence of violet flowers (Fig. 1). It is slightly succulent, aromatic and grows up to 100 cm tall[2]. The leaves are used to treat dysmenorrhoea, haematuria, female sterility, rheumatism, foot infections, convulsions, fever, hypertension, stomach ulcer, hemorrhoid and snakebites; the plant has many ritual uses, especially related to pregnancy[3-6]. Phytochemical studies on *S. monostachyus* leaves afforded the isolation of diterpenoids[7] and essential oil[2]. Research has also shown that the leaf extracts of *S. monostachyus* exhibits antioxidant[8,9], antihypertensive[10], antimicrobial[11] and antiulcerogenic activities[12]. There is paucity of data on the essential oil composition of *S. monostachyus*. Published data on *S. monostachyus* essential oil is limited to the Cameroon leaf oil sample[2].

Fig. 1: *Solenostemon monostachyus* plant

Therefore, in continuation of a systematic analysis of essential oil constituents of relatively poorly studied aromatic medicinal plants[13], we report for the first time, the composition of *S. monostachyus* essential oils from Nigeria.

2 Materials and methods

2.1. Plant Material

The mature *S. monostachyus* plants were collected from the wild in Uyo Local Government Area of Akwa Ibom State, Nigeria, in the month of May 2015. Plant samples were identified and authenticated by a taxonomist, M. E. Bassey, Department of Botany and Ecological Studies, University of Uyo, where voucher specimens were deposited. The essential oils were obtained by hydrodistillation (4 h) of the fresh plant parts using a Clevenger-type apparatus in accordance with the British Pharmacopoeia[14]. The oils were dried over sodium sulfate and kept in refrigeration (4 °C) after estimation of percentage yield.

2.2 Gas Chromatography - Mass Spectrometry (GC – MS)

The essential oils were subjected to GC-MS analysis on an Agilent system consisting of a model 7890N gas chromatograph, a model mass detector Triple Quad 7000A in EI mode at 70 eV (m/z range 40–600 amu) (Agilent Technologies, Santa Clara, CA, USA), and an Agilent ChemStation data system. The GC column was an HP-5ms fused silica capillary with a (5% phenyl)-methyl polysiloxane stationary phase (30 m x 250 µm x 0.25 µm). The carrier gas was helium with a column head pressure of 9.7853 psi and flow rate of 1.2 mL/min. Inlet temperature and MSD detector temperature was 250 ºC.

The GC oven temperature program was used as follows: 50 ºC initial temperature, held for 5 min; increased at 6 ºC/min to 190 ºC for 20 mins; increased 7 ºC/min to 290 ºC for 15 mins; increased 7 ºC/min to 300 ºC for 10 mins. The sample was dissolved in CH_2Cl_2, and 2 µL was injected (split ratio 10:1; split flow 12 mL/min).

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[15]. 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.

3 Result and Discussion

The yields of the leaf, stem, floral and aerial essential oils of *S. monostachyus* were 0.2%, 0.13%, 0.16% and 0.2%, respectively. The aroma profile of *S. monostachyus* volatile oils are presented in Table 1. The essential oil composition of the different plant parts was distinct, quantitatively and qualitatively. A total of fifteen (15) constituents were identified accounting for 89.72% to 98.17% of the oils content and characterized by the high amount of sesquiterpenoid (43.13-91.21%). Monotepenoid was not detected in the leaf and stem oils, however, relatively low in the floral and aerial oils (4.29 % and 9.81% respectively). The leaf oil comprised mainly of β-caryophyllene (71.42%), α-caryophyllene (7.0%), 1-octen-3-ol (6.96%) and caryophyllene oxide (6.67%); the stem oil consisted of β-caryophyllene (46.75%), α-caryophyllene (20.22%), caryophyllene oxide (10.45%) and 1-octen-3-ol (10.31%); the predominant compounds in the floral oil were 1-octen-3-ol (40.24%), β-caryophyllene (18.94%) and α-caryophyllene (16.98%); while β-caryophyllene (27.43%), caryophyllene oxide (24.83%) and α-caryophyllene (12.9%) were the abundant components of the aerial oil. α-caryophyllene, β-caryophyllene and caryophyllene oxide were common constituents of the studied essential oils (Fig. 2).

Analysis also revealed the high amount of 1-octen-3-ol in the floral oil sample (40.24%) relative to other studied plant parts. The leaf essential oil of *S. monostachyus* from Cameroon is reported to contain β-pinene (13.0%), oct-1-en-3-ol (12.6%), β-caryophyllene (6.9%), octan-3-ol (6.8%) and (*E,E*)-α-farnesene (6.2%) as major constituents[2].

β-Caryophyllene occurred in a very high amount in the Nigerian leaf sample compared with the Cameroon sample while β-pinene was not detected in the Nigerian oil. However, several constituents such as 1-octen-3-ol, β-caryophyllene, among others, are common to both leaf oils of different geographical origins. It is worthy of note that caryophyllene rich essential oils such as essential oil of *Stachys cretica* (β-caryophyllene, 51.0%) and β-caryophyllene are reported to exhibit strong antimicrobial activity, particularly against *P. aeruginosa* and *B. subtilis*[16] and cytotoxic activity[17].

4 Conclusions

The volatile constituents of *S. monostachyus* have been analyzed and identified. The leaf, stem, floral and aerial essential oils of *S. monostachyus* from Nigeria displayed significant quantitative and qualitative chemical profiles characterized mainly of sesquiterpene hydrocarbons.

5 Acknowledgements

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6 Conflicts of Interest

The authors declare no conflict of interest.

7 Author Contributions

EEE and PST conceived and designed the experiments; EEE and PST performed the experiments; EEE wrote the manuscript; MIC supervised the experiments.

Table 1: Volatile constituents of *Solenostemon monostachyus*

RI[a]	Compound[b,c]	Leaf	Stem	Flower	Aerial	QI[d]
980	1-Octen-3-ol	6.96	10.31	40.24	-	95
982	β-Pinene	-	-	-	6.96	95
1013	δ-3-Carene	-	-	1.27	1.23	92
1067	(E)-2-Octen-1-ol	-	-	-	5.96	96
1103	β-Linalool	-	-	3.02	-	96
1200	Dodecane	-	-	2.45	-	93
1327	Myrtenyl acetate	-	-	-	1.62	97
1377	α-Copaene	-	-	2.17	2.26	94
1419	β-Caryophyllene	71.42	46.75	18.94	27.43	95
1482	Germacrene D	-	-	-	2.21	97
1524	δ-Cadinene	3.31	-	1.15	2.08	98
1564	α-Caryophyllene	7.0	20.22	16.98	12.90	95
1582	Caryophyllene oxide	6.67	10.45	3.89	24.83	97
1585	Globulol	2.81	-	-	-	94
1645	δ-Cadinol	-	-	-	2.24	96
	Monoterpene hydrocarbons	-	-	1.27	8.19	
	Oxygenated monoterpene	-	-	3.02	1.62	
	Monoterpenoid	-	-	4.29	9.81	
	Sesquiterpene hydrocarbons	81.73	66.97	39.24	46.88	
	Oxygenated sesquiterpene	9.48	10.45	3.89	27.07	
	Sesquiterpenoid	91.21	77.42	43.13	73.95	
	Aliphatic alcohol	6.96	10.31	40.24	5.96	
	Aliphatic hydrocarbons	-	-	2.45	-	
	Total	98.17	87.73	90.11	89.72	

[a]RI, calculated retention indices; [b]Order of elution on HP-5ms capillary column; [c]Identification by comparison of the mass spectral and retention index data; [d]QI, 'quality index', reflects the fit comparison of experimental mass spectrum and NIST library mass spectrum; - = not detected.

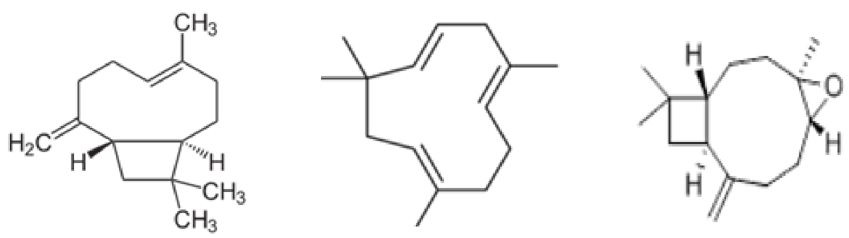

Fig. 2: Common constituents of *S. monostachyus* essential oils: β-caryophyllene, α-caryophyllene and caryophyllene oxide.

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