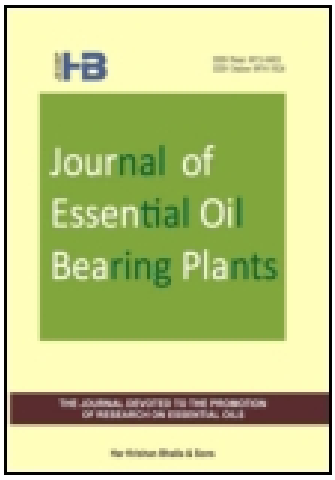

Journal of Essential Oil Bearing Plants
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/teop20

Chemical Composition of Essential Oil from the Seed Arils of Strelitzia nicolai Regel & Koern from South Africa

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Published online: 23 Feb 2015.

Taylor & Francis
Taylor & Francis Group

ISSN Print: 0972-060X
ISSN Online: 0976-5026

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Received 25 December 2013; accepted in revised form 12 April 2014

Abstract: The essential oil components of arils from seeds of *Strelitzia nicolai* were investigated by GC and GC-MS. The oil yields of dried arils obtained by hydrodistillation were 0.86 %. Twenty-five compounds representing 94.2 % of the *S. nicolai* aril oil were identified. The main chemical constituents belongs to alcohols (1.24 %), amides (3.14 %), amine (31.75 %), aromatic compounds (4.86 %), esters (0.65 %), ethers (28.18 %), hydrocarbons (5.13 %) and ketones (19.30 %).

Key words: Essential oil, GC-MS, Chemical composition, *Strelitzia nicolai*.

Introduction

Essential oils are valuable natural products used as raw materials in many fields, including aromatherapy, cosmetics, perfumes, phytotherapy and nutrition [1]. Aromatherapy is the therapeutic use of fragrances or volatiles to mitigate or prevent diseases, infections and indispositions by means of inhalation. This has attracted the attention of many scientists and encouraged them to screen plants to study the biological activities of these oils from their chemical, pharmacological and therapeutic aspects [2]. The purpose of the undertaken research is to characterize the chemical composition of the essential oil extracted from *Strelitzia nicolai* seeds. The family Strelitziaceae comprises three genera, *Strelitzia* (Africa-5 species), *Phenakospermum* (South America-1 species) and *Ravenala* (Madagascar-1 species). *Strelitzia nicolai* (*S. nicolai*) like the other four species of *Strelitzia* produces black seeds with bright orange arils which birds find attractive as a source of food. *S. nicolai* (Regel & Koern) (Fig. 1a) is native to southern Africa and widely cultivated in the tropics. The species grows mostly in coastal dune vegetation and in evergreen forests along the coast. Also, plants inhabit rocky cliff faces where specimens are stunted. It is a common feature of the coastal vegetation from East London to northern KwaZulu-Natal and Mozambique [3]. It is known as the Natal Wild Banana, as the Giant White Bird of Paradise or Wild Banana and is a banana-like plant with distinct stems. Plants could reach a height of over 10 meters with a mop of leaves at the apex and stately white and blue flowers [4].

Fig. 1a. Dehisced capsules illustrating seed arils of *S. nicolai*

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Plants are visited by different groups of animals. Both sunbirds and weavers probe the flowers for the copious nectar. Vervet monkeys eat the seeds and soft parts of the flowers. The arils (Fig. 1b) of the seeds are often eaten by many different species of birds. Tree frogs sometimes hide in the leaf bases. The leaf petioles are dried and used as binding material for hut building and fish kraals [5]. The Zulus use the inflorescence spathes as penis boxes. Seeds of *S. nicolai* are used as a minor food source in that the seeds are powdered, mixed with water and then baked as fritters over open fire. It is recorded that this is a full meal but rather tasteless [6]. In the related example, *Ravenala madagascariensis* the floury seed is cooked in milk and the fat-containing arils benefit children [7].

Fig. 1b. Seeds illustrating arils in *S. nicolai*

A recent discovery [8] of the animal pigment bilirubin in *S. nicolai* has created tremendous interest in the origin of this compound in plants. [9] also found this pigment in the arils and sepals of *S. reginae* (Bird of Paradise flower). They further found this compound in eight other flowering plant species [10]. Usually, this pigment is present as a byproduct in animals and humans when red blood cells are damaged or broken down. It is only in the genus *Strelitzia*. that this chromophore is responsible for colour. There is currently no known pathway in plants that can explain the presence of bilirubin, hence a revision of the tetrapyrrole pathway may lead to answers regarding bilirubin production in plants [11].

Essential oils are an intergral part of the small molecules produced in plants as chemical attractants and as defense systems. As no information has been documented on the essential oil composition in *S. nicholai*, the aim of this study was to investigate the chemical composition of essential oils in the seed arils of this species from South Africa.

Materials and methods

Plant material

Material from plants of *S. nicolai* was collected in September 2010 in the KwaZulu-Natal province of South Africa. The species was identified and a voucher specimen has been deposited in the Ward Herbarium at University of KwaZulu-Natal, Westville Campus, Durban, South Africa. KwaZulu-Natal (Durban) lies at an altitude of ~40 m on latitude (29°48'S) and longitude (30° 56'E).

Extraction of the essential oil

The essential oil from dried arils of *S. nicolai* was extracted using a modification of an established procedure [12]. 100 g of arils were hydrodistilled in a Clevenger apparatus. After five h of distillation, the essential oil was removed from the water surface. The oil was dried over anhydrous sodium sulphate and filtered. The solvent from the filtrate was removed by distillation under reduced pressure in a rotary evaporator at 35°C and the pure oil samples were sealed and kept in an amber colored bottle at 4°C in the refrigerator. The resulting pale yellow oil (40 µL) was dissolved in 1 µmL of methyl ethyl ketone before the injection. 1 µL of this solution was directly used for GC-MS analysis.

Gas chromatography-flame ionization detector (GC-FID)

Oil sample analysis were performed on a Agilent system consisting of a model 6820 gas chromatograph (Agilent, USA), using a fused silica capillary column DB-5, 30 m x 0.35 mm, 0.1 µm film thickness (J & W Scientific, USA). The temperature program was set from 80°C to 280°C in 1-20 min at 15°C/min. The injection temperature was 250°C and the injection volume was 1.0 µL. The inlet pressure was 100 kPa. Nitrogen was used as a carrier gas. Sampling rate was 2 Hz (0.01 min) and flow ionization detector temperature was set at 280°C.

Gas chromatography-mass spectrometry

The GC-MS analysis of the essential oil was performed on an Agilent GC 6890 model gas

chromatograph-5973N model mass spectrometer equipped with a 7683 series auto-injector (Agilent, USA). A DB-5MS column (30 m x 0.25 mm x 0.25 µm film thickness) was used. Temperature program was set from 80°C to 280°C in 1-20 min. Injection volume was 1 µL and inlet pressure was 38.5 kPa. Helium was used as carrier gas. Linear velocity (*u*) was 31 cm/sec. Injection mode was split (75:5). MS interface temperature was 230°C. MS mode was EI, detector voltage was 1.66 Kv, mass range was 10-700 u, scan speed was 2.86scan/s and interval was 0.01 min (20 Hz).

The components were identified by comparing the mass spectra with MS library. The NIST 98 spectrometer data bank was used for identification of the chemical composition.

Results and discussion

Hydrodistillation of arils from the seeds of *S. nicolai* yielded average of 0.86 % essential oil from 100 g of dried arils. The chemical constituents identified in the essential oil with their percentage composition and retention times were tabulated in Table 1. Twenty five compounds, representing 94.25 % of the essential oil were identified, this is higher than the arils of *Ravenala madagascariensis* which has a value of 68.7 % [13]. The GC-MS data showed differences in the profiles of compounds. The heterocyclic amino compound 5-phenyl-1, 3-diazaadamantan-6-one hydrazone (30.97 %) predominated, followed by 1-methyle-guanidine (0.78 %). Other important compounds were the ethers: 1,3-bis (3-phenoxy-

Table 1. Chemical composition of essential oil of arils of *Strelitzia nicolai*

No.	Constituents	Rt (min)*	Mol. Formula	Mol. Wt	Peak Area (%)
	Alcohols				
1	1-Aminopropan-2-ol	4265	C_3H_9NO	75	0.45
2	*N*-Acetyl-D-glucosamine	4778	$C_8H_{15}NO_6$	221	0.60
3	3-Chloro-10,13-dimethyl-2,3,4,7,8,9,10,11 12,13,14,15,16,17-tetradecahydro-1, *H*-cyclopenta[a]phenanthren-17-ol	2355	$C_{19}H_{29}OCl$	308	0.19
	Amides				
4	*N*-Methylpivalamide	4972	$C_6H_{13}NO$	115	0.24
5	*N*-Methyl-1-adamantaneacetamide	2016	$C_{13}H_{21}NO$	207	1.47
6	2-(3-Chlorophenylamino)-2-oxoacetic acid	2117	$C_8H_6NO_3Cl$	199	1.43
	Amine				
7	1-Methyl-guanidine	4843	$C_2H_7N_3$	73	0.78
8	5-Phenyl-1,3-diazaadamantan-6-one hydrazone	2353	$C_{14}H_{18}N_4$	242	30.97
	Aromatic compounds				
9	4-Dehydroxy-*N*-(4,5-methylenedioxy-2-nitrobenzylidene)-tyramine	2147	$C_6H_{14}N_2O_4$	298	2.07
10	1,3-Bis(trimethylsilyl)-benzene	2170	$C_{12}H_{22}Si_2$	222	1.37
11	1,4-Bis(trimethylsilyl)-benzene	2177	$C_{12}H_{22}Si_2$	222	1.42
	Esters				
12	2-Nitrosobutan-2-yl acetate	4355	$C_6H_{11}NO_3$	145	0.46
13	Methyl-3-(acetoxymethyl) biphenylene -2-carboxylate	2366	$C_{17}H_{14}O_4$	282	0.19
	Ethers				
14	Bis-diethyl silicic acid	3516	$C_{10}H_{28}O_4Si_3$	296	8.75
15	2,2,4,4,6,6-Hexamethyl-1,3,5,2,4, 6-trioxatrisilinane	2100	$C_6H_{18}O_3Si_3$	222	2.18

table 1. (continued).

No.	Constituents	Rt (min)*	Mol. Formula	Mol. Wt	Peak Area (%)
16	*tert*-Butyl-(2-isopropyl-5-methylphenoxy)-dimethylsilane	2212	$C_{16}H_{28}OSi$	264	0.24
17	1,3-Bis(3-phenoxyphenoxy)-benzene	3438	$C_{30}H_{22}O_4$	446	17.01
	Hydrocarbons				
18	2-Ethylacridine	2214	$C_{15}H_{13}N$	207	5.13
	Ketones				
19	*N,N,N',N'*-Tetramethylsulfonamide	4255	$C_4H_{12}N_2O_2S$	152	0.46
20	Pentane-2,4-dione	4602	$C_5H_8O_2$	100	0.76
21	2-Methyldihydrofuran-3(2*H*)-one	4798	$C_5H_8O_2$	100	0.60
22	1-(2-(Trimethylsilyloxy) phenyl) propan-1-one	2189	$C_{12}H_{18}O_2Si$	222	0.64
23	Pinazepam	2352	$C_{18}H_{13}N_2OCl$	308	0.18
24	Cyclobarbital	2368	$C_{12}H_{16}N_2O_3$	236	10.28
25	3,5-Di-*tert*-butyl-4-hydroxycyclohexa-2,4-dienone	5923	$C_{14}H_{22}O_2$	222	6.38
	Total				94.25

*Rt- Retention time

phenoxy)-benzene (17.01 %); followed by bis-diethyl silicic acid (8.75 %); 2,2,4,4,6,6-hexamethyl-1,3,5,2,4,6-trioxatrisilinane (2.18 %); and *tert*-butyl-(2-isopropyl-5-methylphenoxy)-dimethylsilane (0.24 %). Seven of the isolated compounds were ketones (19.30 %) of which cyclobarbital (10.28 %) and 3,5-di-*tert*-butyl-4-hydroxycyclohexa-2,4-dienone (6.38 %) predominated. The essential oil also contained smaller percentage of hydrocarbons (5.13 %) which was made up of 2-ethylacridine. Aromatic compounds were also present in a small amount (4.86 %) and were made up of 4-dehydroxy-*N*-(4,5-methylenedioxy-2-nitrobenzylidene)-tyramine (2.07 %). Amides represented only (3.14 %) and the major compound was *N*-methyl-1-adamantaneacetamide (1.47 %). The minor chemical compounds found in essential oil were alcohols and esters at 1.24 and 0.65 %, respectively. The findings emphasize the diversity in the chemical composition of essential oils extracted from the arils of *S. nicolai*. The role of these compounds in essential oils needs to be elucidated. As *S. nicolai* is the first plant from which the animal pigment bilirubin was described, this study lays the foundation of evaluating novel pathways as the compounds may be intermediates of bilirubin production in plants. Further investigations may also lead to novel plant active compounds in our armoury of medicinal compounds. This work provides the first report on the analysis of essential oil from seed arils of *S. nicolai*.

Acknowledgements

This work was financially supported by National Research Foundation and Durban University of Technology, South Africa. KNV is grateful to NRF, South Africa for DST/ NRF Innovation Postdoctoral Fellowship.

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