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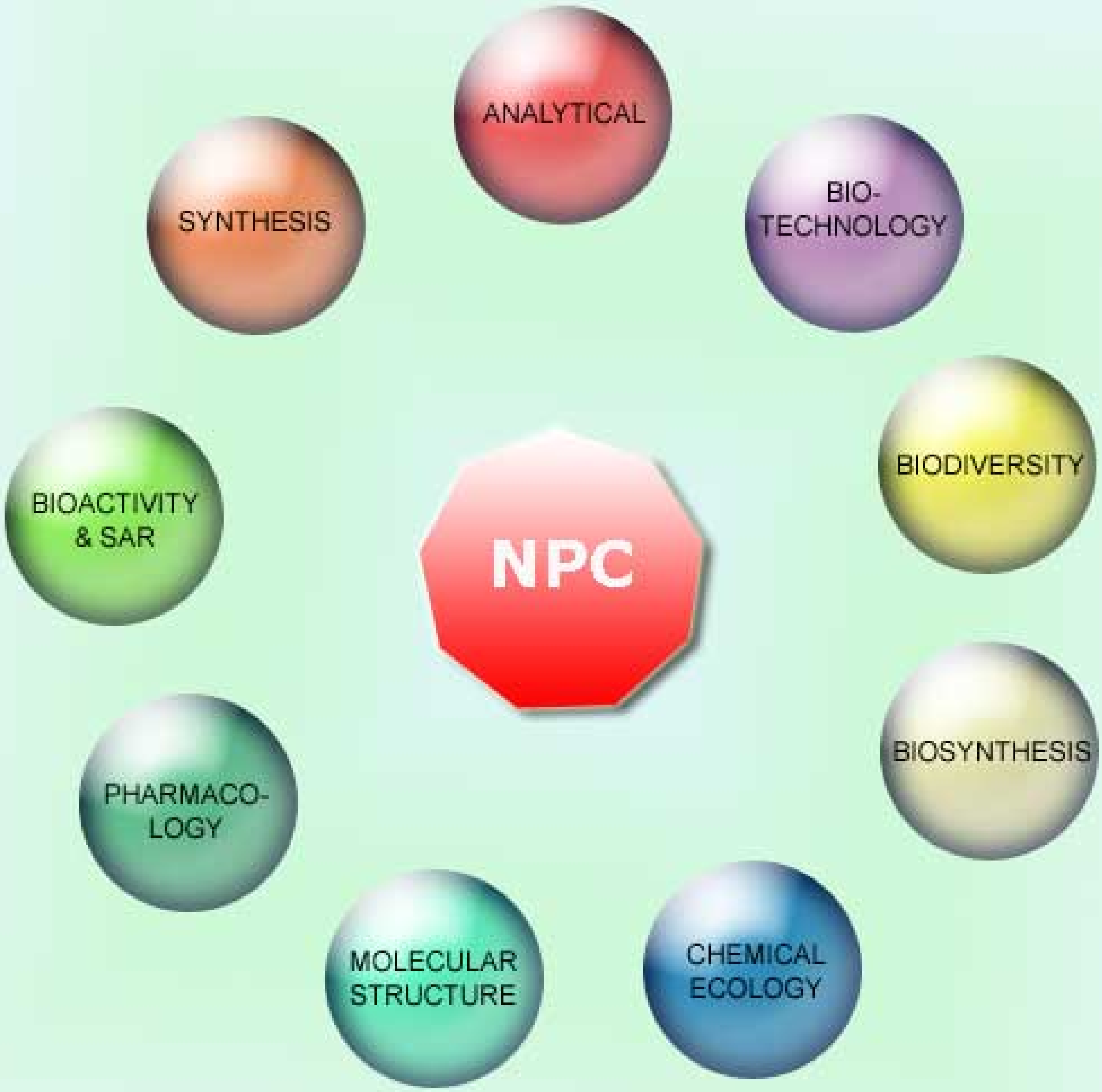

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The Composition of the Essential Oil from *Cyperus distans* Rhizome

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The essential oil from the rhizomes of *Cyperus distans* L.f. obtained by hydrodistillation was analyzed by capillary GC and GC/MS techniques. Eight constituents were identified, representing 99.6% of the total oil. The major components of the oil were cyperene (47.6%), α-pinene (18.8%), 1,8-cineole (14.5%) and caryophyllene oxide (7.3%).

Keywords: *Cyperus distans*, Cyperaceae, essential oil composition, cyperene, α-pinene, 1,8-cineole, caryophyllene oxide.

The genus *Cyperus* L. (family Cyperaceae) is comprised of about 600 species of annual or perennial plants, mostly aquatic and widely distributed in tropical, subtropical and temperate regions [1,2]. *Cyperus* species have been found to possess significant pharmacological and biological properties, including anticonvulsant [3], repellent, antifeedant [4], anti-inflammatory, anti-pyretic, analgesic [5], antibacterial, antimutagenic, antioxidant, cytotoxic, and apoptotic activities [6,7]. In addition, some species have been reportedly used as food [8], as a drug against stomach disorders [2], for making paper [9], and for traditional sleeping mats [8]. Previous phytochemical studies of *Cyperus* species have reported the isolation of flavonoids [10,11], tannins [11], saponins [12], essential oils and many novel sesquiterpenoids [13-19].

In the flora of South Africa, the genus *Cyperus* is represented by over 50 species and varieties, distributed in wet habitats associated with estuarine, riverside and moist areas, particularly in KwaZulu-Natal and Cape Province [2].

C. distans L.f. (Cyperaceae) is an annual herb, about 0.5-1.4 m high, found commonly in damp locations along rivers, roadside ditches and as weeds of cultivation in coastal and midland areas of KwaZulu-Natal. A previous phytochemical study of *C. distans* led to the isolation of scabequinone, which possessed antifeedant activity [20].

Compositional studies of the essential oils of *Cyperus* species are available in the literature [6,7,21-30]. The major constituents identified from most species were mainly sesquiterpenoids. The essential oils of *C. rotundus* from different parts of Asia have been reported to contain α-cyperone (30.7-38.6%), cyperene (7.2-30.8%), cyperotundone (8.8-25.0) and β-selinene (17.8-18.5%) as the principal constituents [21]. In addition, the oils of *C. bulbosus* and *C. tuberosus* from Thailand were dominated by caryophyllene oxide (26.3%) and humulene oxide (24.1%), and δ-cadinene (30.4%) and α-copaene (18.2%), respectively [22].

Ekundayo *et al*. [23] reported the main constituents of the essential oils of two Nigerian *Cyperus* species as α-humulene (30.0%), humulene epoxide II (16.9%), β-caryophyllene (12.1%) and caryophyllene oxide (10.8%) for *C. tuberosus*, and cyperene (19.2%) and α-cyperone (17.7%) for *C. rotundus*. Olawore *et al*. [24] reported on the essential oils of *C. articulatus* (red and black types) from Nigeria and found cyperotundone (42.3%), piperitone (10.1%), β-maaliene (8.4%) and germacrone (5.3%) as the major components of the oil from the red type, while the oil of the black type had cedrol (19.0%), guaia-5-en-11-ol (14.9%) and cyperotundone (9.6%) as the main components. The rhizome oils of *C. rotundus* from Tunisia were found to contain cyperene (20.4-30.9%) and α-cyperone (25.2%) as the major compounds [6,7].

Zoghbi *et al*. [25-27] studied the essential oils of *C. articulatus*, *C. gigantens*, *C. articulatus* var. *articulatus*, *C. articulatus* var. *nodosus*, *C. prolixus* and *C. rotundus* from Brazil. They reported the major components of the stem and rhizome oils of *C. articulatus* to be α-pinene (0.7-12.9%), musakone (7.3-14.5%) and caryophyllene oxide (4.6-28.5%), and of the rhizome essential oil of *C. gigantens* cyperotundone (25.9%) and cyperene (10.4%). The oils of *C. articulatus* var. *articulatus* and *C. articulatus* var. *nodosus* were found to contain mustakone (9.8-14.5% and 6.6-14.5%), and caryophyllene oxide (4.6-10.8% and 5.4-13.7%) as major components, respectively. The oils of *C. prolixus* were characterized by a higher amount of caryophyllene oxide (6.9-26.9%), α-cyperone (13.5-20.6%), and 14-hydroxy-9-*epi*-β-caryophyllene (9.6-16.7%), while, α-cyperone (22.8%) and cyperotundone (12.1%) were the main compounds of the oil of *C. rotundus*.

C. rotundus from India [28] was found to contain α-copaene (11.4-12.1%), cyperene (8.4-11.7%), valerenal (8.7-9.8%), caryophyllene oxide (7.8-9.7%) and *trans*-pinocarveol (5.2-7.4%). The rhizome oil of *C. maculatus* from Chad was reported to contain mustakone (22%) as the major compound [29]. More rarely, the rhizome oils of two varieties (brown and black) of Nigerian *C. esculentus* were found to be potential sources of α-pinene (70.5-75.5%) [30]. In addition, different chemotypes have also been reported for these species [21].

To the best of our knowledge, there is no report concerning the essential oil composition of *Cyperus* species from South Africa, and there is no previous report on the essential oil composition of *C. distans*. Therefore, this paper is reporting for the first time the composition of the volatile oil of *C. distans* growing wild in KwaZulu-Natal, South Africa. The essential oil composition is given in Table 1, where compounds are listed in order of their elution from the DB-5 column. The oil yield was 0.02% (w/w) based on the fresh weight of the plant. Eight constituents were identified, representing 99.6% of the total oil. It is of interest to note that this oil had a relatively high concentration of sesquiterpene hydrocarbons (51.6%), while, the oxygenated sesquiterpene content was 8.6%. Monoterpenes constituted 39.5% of the oil, of which the hydrocarbon fraction was relatively higher (24.9%) than the oxygenated fraction (14.5%). The sesquiterpene composition of the oil was dominated by cyperene (47.6%), caryophyllene oxide (7.3%) and β-cadinene (4.0%). α-Pinene (18.8%), 1,8-cineole (14.5%) and β-pinene (4.5%) were the main monoterpenes.

Table 1: Chemical composition of the essential oil of *Cyperus distans*.

Compound	RRI	%
α-Pinene	938	18.8
β-Pinene	975	4.5
Limonene	1028	1.6
1,8-Cineole	1032	14.5
Cyperene	1396	47.6
β-Cadinene	1471	4.0
Caryophyllene oxide	1583	7.3
Humulene epoxide II	1596	1.3
Monoterpene hydrocarbons		24.9
Oxygenated monoterpenes		14.5
Sesquiterpene hydrocarbons		51.6
Oxygenated sesquiterpenes		8.6
Total identified		99.6

RRI = Retention Relative Indices to C_9-C_{24} *n*-alkanes on the DB-5 column.

All the examined *Cyperus* volatile oils have shown that sesquiterpenes usually predominate, although the relative composition of the constituents varied. α-Cyperone, cyperotundone, β-selinene, mustakone, α-humulene, δ-cadinene, piperitone and cedrol, which were some of the major components of the essential oils of several *Cyperus* species from the previous investigations, were conspicuously absent in this study [6,7,21-29].

Although, monoterpenes such as α-pinene, β-pinene, *p*-cymene, limonene, 1,8-cineole and *trans*-pinocarveol have been reported as constituents of *Cyperus* essential oils [7,25,30], the presence of 1,8-cineole in large amount, as seen in our result, has not been previously reported. However, the composition of the essential oil of *C. distans* from South Africa shows that it is sesquiterpenoids rich, which makes it similar to other reported species of *Cyperus* growing in different parts of the world [6,7,21-29].

Experimental

Plant material: *C. distans* plants growing wild along the KwaDlangezwa road, opposite the University of Zululand, KwaDlangezwa, KwaZulu-Natal, South Africa were collected in October 2006. The material was authenticated in the Department of Botany, University of Zululand, KwaDlangezwa by Dr S.J. Siebert. A voucher specimen [Lawal, OA 01 (ZULU)] was deposited at the University of Zululand, Herbarium.

Isolation of essential oil: Fresh rhizomes (500 g) of *C. distans* were subjected to hydrodistillation in a Clevenger-type apparatus for 4 h in accordance with the British Pharmacopoeia specification [31]. The distillate isolated was preserved in a sealed sample tube and stored under refrigeration until analysis [32,33].

Gas chromatography: GC analyses were carried out on a Hewlett Packard Gas Chromatography HP 6820 equipped with a FID detector and HB-5 MS column (60 m x 0.25 mm id), 0.25 µm film thickness and split ratio of 1:25. The oven temperature was programmed from 50^{o}C (after 2 min) to 240^{o}C at 5^{o}C/ min and the final temperature was held for 10 min. Injection and detector temperatures were 200^{o}C and 240^{o}C, respectively. Hydrogen was the carrier gas at a flow rate of 1 mL/min. The diluted oil (0.5 µL) was injected into the GC. Peaks were measured by electronic integration. ***n***-Alkanes were run under the same conditions for retention indices determinations.

Gas chromatography - mass spectrometry: GC-MS analyses of the oils were performed on a Hewlett Packard Gas Chromatography HP 6890 interfaced with a Hewlett Packard 5973 mass spectrometer system equipped with a HP 5-MS capillary column (30 m x 0.25 mm id, film thickness 0.25 µm). The oven temperature was programmed from 70-240^{o}C at the rate of 5^{o}C/min. The ion source was set at 240^{o}C and electron ionization at 70 eV. Helium was used as the carrier gas at a flow rate of 1 mL/min. The scanning range was from 35 to 425 amu. Diluted oil in *n*-hexane (1.0 µL) was injected into the GC/MS

Identification of components: Identification of the oil components was carried out by comparison of their relative retention times with those of authentic samples, by comparison of their relative retention indices and mass spectra with the Wiley library mass spectra database of the GC/MS system, and published data [34-36].

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Recovery and Purification of Nicotine from Waste Tobacco by Aqueous Two-Phase System/Reverse Extraction
Jian-min Xing, Fen-fang Li and Jing Ping **1093**

Structure Elucidation of Acylsucrose Derivatives from *Atractylodes lanceae* Rhizome and *Atractylodes* Rhizome
Ken Tanaka and Atsutoshi Ina **1095**

The Composition of the Essential Oil from *Cyperus distans* Rhizome
Oladipupo A. Lawal and Adebola O. Oyedeji **1099**

Essential Oil Composition and Enantiomeric Distribution of Fenchone and Camphor of *Lavandula cariensis* and *L. stoechas* subsp. *stoechas* grown in Greece
Olga Tzakou, Ioannis Bazos and Artemios Yannitsaros **1103**

Chemical Composition, Olfactory Evaluation and Antioxidant Effects of Essential Oil from *Mentha x piperita*
Erich Schmidt, Stefanie Bail, Gerhard Buchbauer, Ivanka Stoilova, Teodora Atanasova, Albena Stoyanova, Albert Krastanov and Leopold Jirovetz **1107**

Analysis of Essential Oils of *Artemisia absinthium* L. from Lithuania by CC, GC(RI), GC-MS and ^{13}C NMR
Asta Judzentiene, Félix Tomi and Joseph Casanova **1113**

Chemical Composition and Antibacterial Activity of the Essential Oil of *Cordia verbenacea* from the Venezuelan Andes
Gina Meccia, Luis B. Rojas, Judith Velasco, Tulia Díaz, Alfredo Usubillaga, Juan Carmona Arzola and Sulymar Ramos **1119**

Composition and Antimicrobial Activity of the Leaf Essential oil of *Litsea kostermansii* from Taiwan
Chen-Lung Ho, Eugene I-Chen Wang, Kuang-Ping Hsu , Pei-Yeh Lee and Yu-Chang Su **1123**

Chemical Composition and Antimicrobial Activity of the Essential Oils of Leaves, Roots and Bark of *Glossocalyx staudtii*
Huguette Agnaniet, Thomas Makani, Raphaël Bikanga, Louis Clément Obame, Jacques Lebibi and Chantal Menut **1127**

Composition, Antioxidant and Antimicrobial Activities of the Essential Oil of *Marrubium deserti*
Hocine Laouer, Benalia Yabrir, Amar Djeridane, Mohamed Yousfi, Nicolas Beldovini and Mebarka Lamamra **1133**

Anti-*Helicobacter pylori* activity and Essential Oil Composition of *Thymus caramanicus* from Iran
Fereshteh Eftekhar, Farahnaz Nariman, Morteza Yousefzadi, Javad Hadian and Samad Nejad Ebrahimi **1139**

Differential Acetyl Cholinesterase Inhibition by Volatile Oils from two Specimens of *Marlierea racemosa* (Myrtaceae) Collected from Different Areas of the Atlantic Rain Forest
Amanda Souza, Michelle C. Silva, Elaine M. Cardoso-Lopes, Inês Cordeiro, Marcos E. G. Sobral, Maria Cláudia M. Young and Paulo R. H. Moreno **1143**

Factors Affecting Chemical Variability of Essential Oils: a Review of Recent Developments
Andrea Barra **1147**

Microbial Transformation of Sesquiterpenoids
Haq N Bhatti, Muhammad Zubair, Nasir Rasool, Zahid Hassan and Viqar U Ahmad **1155**

Natural Product Communications
2009
Volume 4, Number 8

Contents

Original Paper **Page**

A New Sesquiterpenoid Coumarin from *Ferula assafoetida*
Anindita Ghosh, Avijit Banerji, Suvra Mandal and Julie Banerji **1023**

Antiproliferative Activities of Five Chinese Medicinal Herbs and Active Compounds in *Elephantopus scaber*
Miaoxian Su, Xia Wu, Hau Yin Chung, Yaolan Li and Wencai Ye **1025**

Naturally Occurring Labdane Diterpene and Benzofuran from *Globba pendula*
Maulidiani, Khozirah Shaari, Christian Paetz, Johnson Stanslas, Faridah Abas and Nordin Haji Lajis **1031**

VCD Determination of the Absolute Configuration of Stypotriol
Marcelo A. Muñoz, Carlos Areche, Aurelio San-Martín, Juana Rovirosa and Pedro Joseph-Nathan **1037**

Bioactive Steroidal Sulfates from the Ambulakrums of the Pacific Starfish *Lysastrosoma anthosticta*
Eleonora V. Levina, Anatoly I. Kalinovsky, Pavel S. Dmitrenok and Dmitry L. Aminin **1041**

Role of Modifier in Microwave Assisted Extraction of Oleanolic Acid from *Gymnema sylvestre*: Application of Green Extraction Technology for Botanicals
Vivekananda Mandal, Saikat Dewanjee and Subhash C. Mandal **1047**

Phytochemical Characterization of an Adaptogenic Preparation from *Rhodiola heterodonta*
Mary H. Grace, Gad G. Yousef, Anvar G. Kurmukov, Ilya Raskin and Mary Ann Lila **1053**

Chemical Composition and Antimicrobial Activity of Wild Garlic *Allium ursinum* of Bulgarian Origin
Antoaneta Ivanova, Bozhanka Mikhova, Hristo Najdenski, Iva Tsvetkova and Ivanka Kostova **1059**

Evaluation of the Antioxidant and Antimicrobial Properties of *in vitro* Cultured *Drosera intermedia* Extracts
Tomás Grevenstuk, Sandra Gonçalves, Sara Almeida, Natacha Coelho, Célia Quintas, Maria Nelma Gaspar and Anabela Romano **1063**

Determination of Phytoestrogen Composition in Soybean Cultivars in Serbia
Jelena Cvejić, Đorđe Malenčić, Vesna Tepavčević, Mihalj Poša and Jegor Miladinović **1069**

Antilonomic Effects of Brazilian Brown Seaweed Extracts
Thaisa Francielle Souza Domingos, Carla Carvalho, Laura de Andrade Moura, Valéria Laneuville Teixeira, Renato Crespo Pereira, Éverson Miguel Bianco, Wilton José Ferreira, Carlos José Brito Ramos, Ana Luiza Palhares de Miranda, Paulo Assis Melo, Jorge Almeida Guimarães and André Lopes Fuly **1075**

Rapid Identification of two Species of *Peucedanum* by High-Performance Liquid Chromatography-Diode Array Detection-Electrospray Ionization Tandem Mass Spectrometry
Yanyan Tao, Jianguang Luo, Yuanyuan Lu, Deran Xu, Zhiguo Hou and Lingyi Kong **1079**

Aaptamine Alkaloids from the Vietnamese Sponge *Aaptos* sp.
Larisa K. Shubina, Anatoly I. Kalinovsky, Sergey N. Fedorov, Oleg S. Radchenko, Vladimir A. Denisenko, Pavel S. Dmitrenok, Sergey A. Dyshlovoy, Vladimir B. Krasokhin and Valentin A. Stonik **1085**

Pancreatic Lipase Inhibitory Alkaloids of *Murraya koenigii* Leaves
Rahul Birari, Somendu Kumar Roy, Anubha Singh and Kamlesh Kumar Bhutani **1089**

Continued inside back cover