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ANALYSIS OF THE ESSENTIAL OIL OF THE ROOTS OF THE MEDICINAL PLANT *KAEMPFERIA GALANGA L.* (ZINGIBERACEAE) FROM SOUTH-INDIA

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The essential oil content of the roots of Kaempferia galanga L. (Zingiberaceae) from South-India was analyzed by gas chromatographic-spectroscopic methods (GC/FID and GC/MS) to identify those compounds responsible for the reported biological activities as well as for the interesting odor of this medicinally used oil. More than sixtyfive constituents were identified. Ethyl-trans-p-methoxycinnamate (52.5%), ethyl -trans-cinnamate (26.3%), pentadecane (4.9%) and 1,8-cineole (2.4%) were found as the major compounds of this essential root oil sample. Further mono- and sesquiterpenes (e.g. borneol, p-cymene, δ-3-carene and α-terpineol as well as α-gurjunene, germacrenes, cadinenes and caryophyllenes) resp. aliphatic hydrocarbons and alcohols were dominating in this root essential oil of K.galanga. The effects of these constituents for the use in medicinal applications as well as their olfactoric properties are discussed.

Keywords: *Kaempferia galanga L., Zingiberaceae, Essential root oil compounds*

Introduction

Kaempferia galanga L. (syn. *Alpinia sessilis* Kon., Zingiberaceae; German name „Gewürzlilie") is native in India(1-7, known there as „chandramula") and cultivated in various Asian countries (e.g. in Indonesia, China and Malaysia, known there as „chekur" or „kencur"). The finger-thick, small, dark root bulbs (rhizomes) from the shrub of *K. galanga* resembles the rhizoma of *Zingiberis officinalis* and possess a variety of medicinal uses as; cough and pectoral remedy, stomachic, carminative, diuretic and cicatrizant(2,4). Also the use of this *Kaempferia* species as a food additive was reported(5). The known main compounds of this root oil are ethyl-trans-p-methoxycinnamate and ethyl-transcinnamate, both showing monoamine oxidase inhibiting and larvicidal effects(4,6). The minor compound isoamyl-trans-p-methoxycinnamate is an important compound in cosmetics used for UV-B-light-protection-filter products(2). Only one author analyzed the compounds of the essential root oil of *K. galanga* from Malaysia with the aim to detect constituents responsible for these medicinal effects(6) respectively for the characteristic odor. Some more papers were published on the analysis of root essential oil volatiles from the better known species *Alpinia galanga* and *A.*

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officinalis Hence (8-10). So, until now no investigation on the volatiles of *K. galanga* root essential oil from South-India was available.

Material

The *Kaempferia galanga* plants were collected near the campus of the Calicut University in spring 2000 and the species were identified by Dr. A.K. Pradeep, Department of Botany, Calicut University, Kerala. A voucher specimen (no. 30) was given to the herbarium of the Calicut University, Department of Chemistry. The fresh rhizomes (250g) were ground into a paste using an electric grinder. The essential oil was obtained by steam distillation of the paste for 3 hours. The distillate was extracted with diethyl ether and dried using anhydrous sodium sulphate. After evaporation of the ether under vacuum a yield of 0.6g essential root oil was obtained.

After moistening a commercial odor strip (Dragoco Co. Austria) with some drops of each essential oil, the odor was evaluated by professional perfumers.

Methods

Gas chromatography with Flame Ionization Detection (GC/FID)

The GC/FID analyses were carried out using a GC-14A with FID and the integrator C-R6A-Chromatopac (Shimadzu Co., Japan) resp. GC-3700 with FID (Varian Co., Germany) and the integrator C-R1B-Chromatopac (Shimadzu Co., Japan); carrier gas: hydrogen; injector-temperature: 250^{0}C; detector-temperature: 320^{0}C; temperature-program: 40^{0}C/5 min. to 280^{0}C/5 min. with a heating-rate of 6^{0}C/min.; columns: 30mm x 0.32mm bonded FSOT-RSL-200 fused silica (film thickness: 0.25 µm, Biorad Co., Germany) and 30m x 0.32mm bonded Stabilwax (film thickness: 0.50 µm, Restek Co., USA); quantification by %-peak area calculations and compound identification partly by retention time correlations according to references(11-15).

Gas chromatography with Mass spectrometry (GC/MS)

For GC/MS measurements a GC-17A with a QP5000 (Shimadzu Co., Japan) and the data system Compaq-ProLinea (USA, class 5k software), then a GC-HP5890 with a HP5970-MSD (Hewlett-Packard Co., USA) and the PC-Pentium (Böhm Co., Austria, ChemStation software) resp. a GCQ (Finnigan-Spektronex Co., Germany-USA) with the Gateway-2000-PS75 data system (Siemens-Nixdorf Co., Germany, GCQ software) were used; carrier gas: helium; injector-temperature: 250^{0}C; interface-heating: 300^{0}C; ion source-heating: 200^{0}C; EImode: 70 eV; scan-range: 41-450 amu; other parameters see GC/FID part; mass spectra correlations with Wiley-, NBS-, NIST- and own library spectra as well as published spectral data(12, 16, 17).

Results and Discussion

The root essential oil of *Kaempferia galanga* from South-India was olfactorically evaluated and the odor was described as aromatic-spicy (direction of fresh *Zingiberis officinalis* roots) and pleasant-fresh (direction of *Eucalyptus* and *Peppermint*).

Using gas chromatographic-spectroscopic methods (GC/FID and GC/MS) more than fourty constituents were identified in this essential oil (Table).

As main compounds (concentration higher than 2%) of the root essential oil of *K. galanga* from South-India, ethyl-trans-p-methoxycinnamate (52.5%), ethyl-transcinnamate (26.3%), pentadecane (4.9%) and 1,8-cineole (2.4%) were found, among further mono- and sesquiterpenes, aliphatic hydrocarbons and aliphatic alcohols. For the first time the cis-isomer of ethyl-cinnamate was identified as minor constituent of this *Kaempferia* species (ethyl-cis-cinnamate was found as genuine component in plum-brandy and therefore identified by retention-timecorrelations with these published data(15) respectively by mass spectra correlation with the well-known trans-isomer) as well as the cosmetically-interesting compound isoamyl-trans-p-methoxycinnamate (trace) in a South-Indian sample.

Table : Volatiles of the root essential oils of *Kaempferia galanga* from South-India

Compound+	Concentration (%)*	ID0
ethyl-trans-p-methoxycinnamate	52.5	2,6,7,17
ethyl-trans-cinnamate	26.3	2,6,7,12-18
pentatdecane	4.9	2,6,7,11-18
1,8-cineole	2.4	2,6,7,11-18
borneol	1.2	2,6,7,11-18
p-cymene	0.8	6,11-18
δ-3-carene	0.5	6,7,11-18
α-gurjunene	0.5	6,11-18
α-terpinedl	0.5	6,7,11-18
carvone	0.4	11-16
artemisia alcohol	0.4	11-16
ethyl-cis-p-methoxycinnamate	0.4	7,18
p-cymen-8-ol	0.4	6,12-14,16
germacrene D	0.3	6,7,12-17
trans-isomyrcenol	0.3	6,12-17
ethyl-cis-cinnamate	0.3	13,15
carvone oxide	0.3	11-17
δ-cadinene	0.3	6,11-14,16
camphene	0.2	6,7,11-17
verbenol	0.2	11-14,16
limonene	0.2	6,11-14,16
myrtenal	0.2	11-14
β-caryophyllene	0.2	6,11-14,16
bornyl acetate	0.2	2,6,11-14,16
α-pinene	0.2	2,6,11-14,16
terpinene-4-ol	0.2	11-14
β-pinene	0.1	2,6,11-17
hexadecanol	0.1	11-17
verbenone	0.1	11-14
linalool	0.1	11-17
germacrene B	0.1	11-17
methyl-trans-p-methoxycinnamate	0.1	6,13,18
β-phellandrene	0.1	11-14
octanol	0.1	6,7,11-17
isoamly-trans-p-methoxycinnamate	0.1	2,14
muurolol	0.1	11-14,16
2-hydroxy-1,8-cineole	0.1	13
δ-cadinol	0.1	11-17
caryophyllene oxide	0.1	11-17
trans-β-ocimene	0.1	11-17
β-myrcene	0.1	6,7,11-17
γ-terpinene	0.1	6,7,11-17
terpinolene	0.1	6,7,11-17
pentadecanol	0.1	11-14
α-humulene	0.1	11-14
piperitenone	0.1	6,7,11-14

Table continued.

isobornyl acetate	0.1	11-14
tridecane	0.1	11-14
decanol	0.1	11-14
β-elemene	0.1	6,7,11-14
hexadecane	0.1	11-14
α-terpinene	tr#	11-14
octanal	tr	11-14
heptadecane	tr	11-14
limonene oxide	tr	11-14
dihydrocarveole	tr	11-14
carvacrol	tr	6,11-14
tetradecane	tr	6,11-14
γ-elemene	tr	11-17
germacrene A	tr	11-17
benzaldehyde	tr	6,11-17
sabinene	tr	11-14
alloaromadendrene	tr	11-14,16
α-copaene	tr	6,11-14,16
tridecane	tr	6,11-14
cis-β-ocimene	tr	11-14,17
p-methoxybenzaldehyde	tr	6,11-14
indole	tr	6,7,11-14
cinnamic acid	tr	2,6,7,11-14

+ in order of their concentrations
* calculated as %-peak area of GC/FID analyses
0 identification in accordance to published retention time and mass spectral data
trace compound (less than 0.1%)

The analytical data can be correlated to the olfactonic data very well. The cinnamate derivatives are responsible for the aromatic-spicy odor impression, whereas especially the monoterpenes, like 1,8-cineole, borneol, δ-3-carene, carvone and carvone oxide generally possess pleasant-fresh odor notes.

The correlation of the composition of the root essential oil of *K. galanga* from South-India with published biological data of this *Kaempferia* species elsewhere(1-7) allows for the statement that this sample can be used in medicinal applications as well. Also for the food (additive) and cosmetic (UV-B-light-

protection-filter) industry, this essential oil could be interesting (18).

In conclusion we can report that the essential oil of *Kaempferia galanga* roots from South-India are rich in ethyl-trans-p-methoxycinnamate, ethyl-transcinnamate and 1,8-cineole. For the first time the cis-isomer of ethylcinnamate was found in this *Kaempferia* species. The characteristic aromatic-spicy and pleasant-fresh odor of this oil can be attributed to the main cinnamate derivatives as well as to some monoterpenes. The correlation of the composition of this South-Indian sample with published biological, cosmetic and nutritional data of this *Kaempferia* species shows the useful application of this oil in medicinal treatments, cosmetic products and foodstuff.

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