

The leaf essential oil of *Costus afer* Ker–Grawl from Nigeria

Asekun O. Taiwo^{1*} and Adeniyi A. Bolanle²

¹ Department of Chemistry, Lagos State University, PMB 1087, Apapa, Lagos, Nigeria

² Department of Pharmaceutical Microbiology and Clinical Pharmacy, College of Medicine University of Ibadan, Ibadan, Nigeria

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ABSTRACT: Detailed systematic and comprehensive analysis of the essential oil of the leaves of *Costus afer* Ker–Grawl (Zingiberaceae) from the western part of Nigeria by capillary gas chromatography (GC) and gas chromatography–mass spectrometry (GC–MS) led to the identification of 27 compounds from 38 compounds in the essential oil. The results showed that sesquiterpenoids were the most abundant group of volatile compounds, with sesquilandulyl acetate (17.0%) as the principal component. β -caryophyllene (12.3%) and *Z,E*-farnesol (9.9%) were also present in reasonable quantities. Investigation of the antimicrobial activity of the essential oil showed that it is inactive. Copyright © 2003 John Wiley & Sons, Ltd.

KEY WORDS: *Costus afer*; Zingiberaceae; essential oil; sesquilandulyl acetate; antimicrobial activity

Introduction

The plant *Costus afer*, which bears white and yellow flowers,¹ is mainly found in the forest region of South Africa, Guinea, Niger, Sierra Leone and Nigeria.²

Various parts of the plant are used for the treatment of different ailments, such as rheumatism, eye drops for various infections, headache, cough, diuretic, urethral discharge and malaria.

The absence of reports on the leaf essential oil composition of this plant in the literature prompted this investigation.

Experimental

The leaves of the plant were collected from plants growing around the Eleyele area in Ibadan, Nigeria, in December 1996. Mr A. Odewo of the Forest Research Institute of Nigeria (FRIN), Ibadan, identified the plant and herbarium specimens were deposited.

The leaves were air-dried for 5 days and were finely powdered using a mechanical miller. The powdered plant material was hydrodistilled as described previously.³

Gas chromatography (GC) and gas chromatography–mass spectrometry (GC–MS) were performed exactly as described previously.³

The antimicrobial activities of the oil were investigated using the agar disc diffusion method, as described by Kavanagh⁴ and Janssen *et al.*⁵

Results and Discussion

The detailed GC and GC–MS analyses of *C. afer* leaf essential oil showed the occurrence of 38 compounds (82.2%), as shown in Table 1; 27 compounds (81.9%) were identified by retention index system and by comparing their mass spectra with those in the literature.

The monoterpene profile consisted of six monoterpene hydrocarbons and five oxygenated monoterpenes. Sesquiterpenes were the most abundant in the essential oil (59.6%). The identified sesquiterpenes hydrocarbons were β -caryophyllene (12.3%) and β -selinene (1.5%).

Sesquilandulyl acetate (17.0%) was the principal component of the leaf essential oil. Twelve other oxygenated sesquiterpenes present include *Z*-dihydrofarnesol, dihydrofarnesol, *Z,E*-farnesol, caryophyllene oxide, and *Z*- and *E*-citronellyl tiglate. Abietatriene (4.0%) was the only diterpene identified.

Nothing could be traced in literature concerning the composition of the essential oil of *C. afer*. However, essential oil from the root was reported by Oliver⁶ to be used in curing diuretic cough and rheumatism, confirming the fact that the plant possesses essential oil.

The essential oil did not have an inhibitory effect against any of the test organisms used, as can be seen in Table 2. The non-antimicrobial activity of the essential

* Correspondence to: O. T. Asekun, Department of Chemistry, Lagos State University, PMB 1087, Apapa, Lagos, Nigeria.
E-mail: taiwoasekun@yahoo.com

Table 1. Leaf essential oil composition of *Costus afer* Ker–Grawl

Peak No. ^a	Compound	Mass spectral data ^b	KI	Composition (%)	Method of identification ^c
1	α -Thujene	93, 77, 41, 91	927	0.8	RI, MS
2	α -Pinene	93, 41, 77, 92	938	0.6	RI, MS
3	Sabinene	93, 77, 41, 91	958	1.0	RI, MS
4	β -Pinene	93, 41, 69, 79	977	0.9	RI, MS
5	Δ -3-Carene	93, 41, 91, 77			RI, MS
6	α -Terpinene	93, 121, 91, 136	1050	1.9	RI, MS
7	Terpinen-4-ol	71, 93, 111, 41	1172	1.2	RI, MS
8	<i>trans</i> -Piperitol	83, 55, 98, 41	1289	2.3	RI, MS
9	Geranial	41, 69, 43, 84	129	0.4	RI, MS
10	<i>Z</i> -Theaspirane	138, 82, 41, 96	1297	0.5	RI, MS
11	<i>E</i> -Theaspirane	138, 82, 96, 41	1375	4.7	RI, MS
12	β -Caryophyllene	41, 93, 69, 133			RI, MS
13	Uj ^d	43, 69, 41, 151	1401	12.3	RI, MS
14	β -Ionone	177, 143, 135, 91	1434	4.5	RI, MS
15	β -Selinene	41, 93, 105, 79	1478	1.5	RI, MS
16	<i>Z</i> -Dihydro-farnesol	69, 41, 81, 43	1499	1.1	RI, MS
17	<i>Z,E</i> -Nerolidol	69, 41, 55, 81	1527	1.6	RI, MS
18	<i>Z</i> -Dihydro-farnesol	41, 69, 55, 43	1575	0.6	RI, MS
19	Caryophyllene oxide	41, 79, 69, 93	1582	0.5	RI, MS
20	<i>Z,E</i> -Farnesol	69, 41, 81, 55	1611	9.9	RI, MS
21	<i>Z,Z</i> -Farnesol	41, 69, 43, 55	1631	0.4	RI, MS
22	Uj ^d	41, 91, 55, 69	1648	0.7	RI, MS
23	Uj ^d	434, 55, 57, 82	1681	0.4	RI, MS
24	Uj ^d	57, 43, 91, 71	1684	0.3	RI, MS
25	<i>Z</i> -Dehydro-apo-farnesol	41, 69, 81, 55	1687	0.6	RI, MS
26	Uj ^d	57, 183, 41, 43	1690	0.9	RI, MS
27	Uj ^d	41, 55, 69, 43	1712	0.9	RI, MS
28	Uj ^d	41, 69, 43, 55	1727	12.9	RI, MS
29	<i>Z</i> -Citronellyl tiglate	43, 41, 55, 57	1731	2.6	RI, MS
30	<i>E</i> -Citronellyl tiglate	82, 43, 57, 55	1749	0.7	RI, MS
31	Methyl linoleate	67, 41, 81, 55	1798	0.8	RI, MS
32	β -Acoradienol	79, 41, 67, 55	1802	1.4	RI, MS
33	Sesquilavandylyl acetate	43, 69, 41, 81	1809	17.0	RI, MS
34	Uj ^d	257, 41, 55, 69	1886	1.0	RI, MS
35	Uj ^d	227, 41, 55, 43	2018	1.7	RI, MS
36	Abietatriene	255, 69, 41, 117	2153	4.0	RI, MS
37	Uj ^d	57, 43, 71, 85	2268	1.3	RI, MS
38	Uj ^d	57, 43, 71, 85	2376	0.3	RI, MS

^a GC Peak number (elution order on Cpsil 5 capillary column) (BP 1).

^b Main fragments in decreasing order.

^c Identification by KI and using the mass spectral data in the literature.

^d Unidentified compound.

Table 2. Antimicrobial activity of the leaf essential oil of *C. afer*

	Inhibition zones									
	Sa UCH560	Sa UCH681	Sa UCH511	Ec NCTC7001	Ec UCH307	Ec UCH270	Pa NCTC6750	Pa UCH655	Bc	Ca
<i>Costus afer</i> oil	—	—	—	—	—	—	—	—	—	—
Gentamycin	14 ± 0.2	—	12 ± 0.2	14 ± 0.3	14 ± 0.2	14 ± 0.4	—	10 ± 0.2	—	NT
Ampicillin	R	—	R	—	9 ± 0.4	12 ± 0.3	—	9 ± 0.4	—	NT
Tioconazole	NT	NT	NT	NT	NT	NT	NT	NT	NT	16 ± 0.3

Sa UCH560, *Staphylococcus aureus* UCH560; Sa UCH681, *Staphylococcus aureus* UCH681; Sa UCH511, *Staphylococcus aureus* UCH511; Ec NCTC7001, *Escherichia coli* NCTC7001; Ec UCH307, *Escherichia coli* UCH307; Ec UCH270, *Escherichia coli* UCH270; Pa NCTC6750, *Pseudomonas aeruginosa* NCTC6750; Pa UCH655, *Pseudomonas aeruginosa* UCH655; Bc, *Bacillus cereus*; Ca, *Candida albicans*.

Mean values ($n = 3$) ± SD are given.

DM, dimethyl sulphoxide; HX, hexene; R, resistant; NT, not tested; —, no inhibition, UCH: Clinical isolates, University of Ibadan, College Hospital Collection, NCTC: National Collection Type Cultures.

oil at the concentration used is contrary to its traditional uses for treatment of ailments such as eye infections, cough and urethral discharge.² However, these uses could be explained by the report of Aguiyi *et al.*,⁷ which stated

that the aqueous extract of the plant demonstrated antimicrobial activity against some bacteria and fungi. This indicates that the plant possess some antimicrobial agents which are not volatile compounds.

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