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Traditional medicinal uses and essential oil composition of leaves and rhizomes of korarima (*Aframomum corrorima* (Braun) P.C.M. Jansen) from southern Ethiopia

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Abstract

Ethnobotanical surveys were conducted in Gamo Gofa, Debub Omo and Kaffa; which are the three major korarima (*Aframomum corrorima* (Braun) P.C.M. Jansen) growing regions of southern Ethiopia. Plant parts used as a medicine for different aliments were documented. Eighty-three percent of key informants replied that seeds were mostly used as traditional medicine followed by leaves (75%) and rhizomes (72%). The remedies were prepared from freshly collected plant materials and were mostly taken orally. The values of preference ranking on the main use categories of korarima indicated that the cash value obtained from sale of korarima was the 1st use category for the majority of interviewed key informants.

Essential oils of korarima were obtained by hydrodistillation. The oil refractive indices were recorded for leaf (1.494) and rhizome (1.445). When analyzed by GC and GC/MS, 38 (leaf) and 52 (rhizome) compounds were identified from the essential oils. The major component of the oil of the leaf was β-caryophyllene (60.7%). The rhizome oil was dominated by γ-terpinene (21.8%) and β-pinene (17.6%).

Keywords: β-caryophyllene; *Aframomum corrorima*; Korarima; Traditional use; β-pinene; γ-terpinene

1. Introduction

Korarima (*Aframomum corrorima* (Braun) P.C.M. Jansen) also called Ethiopian cardamom, is native to Ethiopia. It is mainly grown in southern, south-western and western Ethiopia, and belongs to the family Zingiberaceae, the genus *Aframomum*.

Korarima is a perennial, tropical shade loving, aromatic herb, often of large size, bearing flowers either terminally on aerial leaf shoots or from the ground level. It grows usually with strong fibrous subterranean scaly rhizomes and with leafy stems reaching 1–2 m height. Korarima is one of the aromatic medicinal plants used in traditional medicine by the people of southern Ethiopia. According to Addis et al., (2001) traditional medicine still remains the main resource for a large majority of the people in Ethiopia and has a much lower price than modern medicine. Giday (1999) reported a depletion of medicinal plants from natural habitats due to environmental degradation and intense destruction of natural forests. According to Abebe (1996), about 80% of Ethiopians, depend on traditional herbal medicines. The extraction and characterization of essential oils from aromatic and medicinal plants might be an entry point to the pharmaceutical industry to discover and develop new drugs.

Although there are no available research data on the medicinal uses of different tissues of korarima, the amount of plant parts used, by local people as medicine are considerable. Due to the high value of seed as spice, the present returns obtained from sales are much higher than most of other food cereal crops in the growing regions (EARO, 2000). The seeds of korarima contain different types of essential oil components (1–2%) with a typical odour (Jansen, 1981; Abegaz et al., 1994; Baser and Kürkcüoglu, 2001). According to Baser and Kürkcüoglu (2001) and Hymete et al. (2006), the major

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components of the essential oil from dried seeds were 1,8-cineole, which varied between 33 and 44% and the sesquiterpene (*E*)-nerolidol (17%) which was most abundant in the dried pods collected from local markets (Hymete et al., 2006). In our previous work (Eyob et al., 2007) on fresh materials, the major constituents of the oil were found to be γ-terpinene (27.1%) in pods and 1,8-cineole (39.3%) in seeds. Martin et al. (2006) also described 1,8-cineole from *Aframomum exscapum* as the main essential oil constituent. According to Tane et al. (2005), some of the *Aframomum* species are known for the production of labdane diterpenoids, flavonoids, sesquiterpenoids and arylalkanoids which may act against micro-organisms. The leaf oil of *Aframomum stipulatum* showed high activity against selected micro-organisms (Cimanga et al., 2002). To the authors' knowledge, the volatile constituents of leaves and rhizomes, and traditional medicinal uses of korarima have not been reported before; although, these parts of the plant are well known in traditional medicine. The potential bioactive principles have not been characterized yet. In this study, we report the chemical composition of the essential oils from the leaf and rhizome of korarima and also document the results of the surveys conducted on the status of traditional medicinal uses of korarima in southern Ethiopia.

2. Materials and methods

2.1. Traditional medicinal uses of korarima

Ethnobotanical surveys were conducted in Gamo Gofa, Debub Omo and Kaffa which are the three major korarima growing regions of southern Ethiopia, after a special permit was obtained from the regional government, Zonal Agriculture and Rural Development Offices. The study was carried out between May and June 2005 from 9 o'clock in the morning to 5 o'clock in the afternoon using semi-structured interviews and random sampling techniques. Information were obtained on the traditional medicinal uses of korarima. All interviews and discussions were carried out in Amharic, the official language of Ethiopia, and in the respective local language of different ethnic groups with help of translators. Twelve knowledgeable key informants in each study area were interviewed. Every key informant was interviewed for about 25 min in a place suitable for the informant. Specific questions were raised on the different uses of korarima such as medicine, spices, income sources, soil conservation and other household uses. All responses were recorded in a note book. The preference ranking procedures and techniques according to Martin (1995) were followed to rank some selected use values of korarima. The informants were compensated for all the time they spent with the researcher. Descriptive statistics were used to organize, summarize and describe the obtained data. Mean values and percentages were calculated.

2.2. Plant material and isolation of the essential oils

Fresh leaves and rhizomes of korarima 'Mume', were collected from contact farmer field at Chencha in the highlands of southern Ethiopia in June 2005. Planting material was also collected of the same cultivar and planted at the horticultural garden of Hawassa University for further study in the future. The plant materials were collected in paper bags and stored in a refrigerator at 4–5 °C for 36 h before transported to the laboratory in Addis Ababa, which is located at 510 km away from the area where the samples were collected. The leaf and rhizome samples (100 g) were hydrodistilled (3 replicates) for 4 h at normal pressure using a Clevenger type apparatus. Using the same sample size, moisture contents of leaves, rhizomes, pods and seeds were determined by calculating loss of weight after oven drying. The leaf and rhizome essential oils (10 µl) were diluted in 1 ml *n*-hexane before injection.

2.3. Gas Chromatography (GC)

The essential oil was analysed using a Varian CP3800 gas chromatograph, equipped with a DB 5 capillary column (30 m × 0.25 mm, 0.25 µm film thicknesses). Nitrogen was used as carrier gas with a flow rate of 1 ml/min (split 1:20). The injector temperature was 220 °C. The injected sample volume was 0.2 µl. The temperature programming was: 70 °C to 240 °C at 3 °C/min with a detector temperature of 280 °C.

2.4. Gas Chromatography/Mass Spectroscopy (GC/MS)

The essential oil was analysed using a CP-Sil 8CB-MS column (30 m × 0.25 mm; film thickness 0.25 µm). The carrier gas was helium with flow rate of 1 ml/min (split 1:20). The injector temperature was 220 °C. Injected sample volume was 0.2 µl. Temperature was programmed: 60 °C to 280 °C at 3 °C/min. The ionisation energy was 70 eV, and the mass range *m/z* 40–450.

2.5. Identification of essential oil components

The components were identified by their mass spectra and retention indices. The mass spectra were compared with Wiley mass spectral library. The fragmentation patterns of the mass spectra were compared with those reported in the literature (Adams, 1995) and/or by co-injection of authentic standards whenever available. Refractive indices for leaf and rhizome oils were determined at 25 °C using an Abbe refractometer.

3. Results and discussion

3.1. Traditional medicinal uses

Based on the responses of the key informants the uses of korarima were many and varied. Traditionally, korarima has been used as spices, medicine, an income source and means of soil conservation for the growers. A higher proportion of key informant (83.3%) elders replied that the seed was the part of the korarima plant that was most commonly used as a traditional medicine followed by leaf (75%) and rhizome (72%) (Table 1). According to some of the informants, the use of roots will increase when the leaves and rhizome are not available

Table 1
The parts of korarima used as traditional medicine, and the percentages of key informants ($n=36$) knowing the use of the particular part as medicine

Part used	Region			Over all	
	Gamo Gofa	Debub Omo	Kaffa	Mean of regions	Rank
	%	%	%	%	
Seed	66.7	83.3	100	83.3	1st
Leaf	58.3	66.7	100	75	2nd
Rhizome	50	66.7	100	72	3rd
Root	25	33.3	50	36	4th
Pod	16.7	25	41.7	27.8	5th
Flower	0	0	16.7	16.7	6th

anymore. The use of flowers as traditional medicine was only known in the Kaffa area. The ethnomedicinally important varieties within the same species varied from region to region. In all three study regions, most of the medicines are collected from wild plants close to the places where the informants live. Occasionally the medicines were collected from cultivated plants at the home gardens.

The traditional use, forms of preparation and mode of use were different depending on the plant parts (Table 2). In all areas, leaves and rhizomes were the most frequently utilized plant parts for farm animals while the seeds were used as human medicine. The major administration routes were oral. The remedies are mostly taken with water but sometimes the seed powder was suspended in milk. The leaves with or without crushing was used to rub or wrap against animal body swelling and skin wound. A decoction of the rhizomes was used against parasitic nematodes, *Mammomonogamus* species in ruminant animals. The seed was effective against tonic convulsions, carminative, purgative, headache, stomach-ache and sore throat when taken orally. According to the informants, the dose taken was not standardized, and was dependent on the patient's age, health condition, and physical appearance and on the experience of the herbalist, which is in agreement with the findings of Addis et al. (2001). There were no reported adverse effects for the use of korarima as traditional medicine. Our present results on the medicinal use of korarima implies one of the indigenous uses of oil bearing plants of Ethiopia which is in agreement with findings of Sebsebe (1993).

In this study, there was a knowledge difference regarding traditional uses of korarima. The inhabitants in the Kaffa area were more knowledgeable compared to the other two study areas probably due to long term uses of korarima by local people as the korarima was native to the natural forests of Kaffa with association of coffee (*Coffea arabica*). In our study we also found that some of the local people were not willing to give any information on medicinal plants for the reasons that it was the traditional belief not to tell anybody about the medicine. The belief was that the effectiveness of plant would be lost and

Table 2
Traditional medicinal uses of korarima

Region	Medicinal uses				
	Local name [a]	Plant part	Uses	Preparation	Mode of use
Gamo Gofa	Gelesh	Leaf	Animal body swelling, skin wound [b]	Crushed leaves or without crushing	Crushed leaves rubbed on body or leaf wrapped as a bandage
		Rhizome	*Mammomonogamus* species (Nematoda, Syngamidae) in ruminants	Decoction	Oral
		Root	Animal disorder [b]	Decoction	Oral
	Mesketo	Pod	Intestine and throat problems	Decoction or fresh and dry pod chewing	Oral
		Seed	Carminative, tonic, head ache, stomach ache, sore throat	Ground and added to drink or other food stuffs	Oral
Debub Omo	Gaye	Leaf	Animal body swelling, skin wound [b]	Crushed leaves or with out crushing	Crushed leaves rubbed on body or leaf wrapped as a bandage
		Rhizome	*Mammomonogamus* species (Nematoda, Syngamidae) in ruminants	Decoction	Oral
		Root	Animal disorder [b]	Decoction	Oral
	Gaco	Pod	Intestine and throat problems	Decoction drunk or fresh and dry pod chewing	Oral
		Seed	Carminative, tonic, head ache, stomach ache, sore throat	Ground and added to the drink or other food stuffs	Oral
Kaffa	Shetto	Leaf	Animal body swelling, skin wound [b]	Crushed leaves or with out crushing	Crushed leaves rubbed on body or leaf wrapped as a bandage
		Rhizome	*Mammomonogamus* species (Nematoda, Syngamidae) in ruminants	Decoction	Oral
		Root	Animal disorder [b]	Decoction	Oral
		Flower	Animal body wound [b]	Crushed flower	External
	Mache	Pod	Intestine and throat problems	Decoction or fresh and dry pod chewing	Oral
		Seed	Carminative, tonic, head ache, stomach ache, sore throat	Ground and added to the drink or to other food stuffs	Oral

[a] Local name indicates korarima types.
[b] Refers to domestic animals.

Table 3
Primary use categories of korarima as ranked by the key informants

Use category	Mean score of each region			Weighted mean	Over-all rank
	Gamo Gofa	Debub Omo	Kaffa		
Income source	3.3	3.5	3.9	3.6	1st
Spice for home use	3.6	2.9	3.1	3.2	2nd
Medicine	1.7	2.3	2.0	2.0	3rd
Soil conservation	1.4	1.3	1.0	1.2	4th

1 and 4 are the highest and lowest scores, respectively.

misused by other people. This belief varied from region to region depending on the cultural and religious conditions of the local community. When compared with elder people, the younger generation undermined the use of traditional medicine from korarima and other plants considering such practices as traditional and backward, which are in conformity with reports of previous studies (Giday, 1999; Teshome, 2005).

After analysing the mean scores and weighted means of the three regions, the values of preference ranking on the use categories of korarima showed that the cash value obtained from sale of korarima was the 1st use category for the majority of the interviewed key informants in Debub Omo and Kaffa followed by spice, medicine and soil conservation as 2nd, 3rd and 4th use category, respectively (Table 3). In Gamo Gofa, however, the use value of korarima as a spice was given the highest priority. The local people explained that korarima has been one of the most important plants for soil conservation as the plant parts, particularly the rhizomes and leaves spread on the ground covering and protecting the soil from erosion in hilly areas the year around. It has also been used for fertilization of the farms after chopping. In this study we also found that the plants that were widely used as traditional medicine or remedy by the local people for a specific aliment were given higher values. The results of this survey study indicate that the local people in the rural areas are still dependent on the medicinal use of korarima. However, more detailed pharmacological investigations are required to further explore the scientific basis of indigenous knowledge available on the use of korarima.

3.2. Essential oils

The oil yields of korarima leaves (0.5%) and rhizomes (0.7%) on dry w/w basis (data not shown) were lower compared to the oil from seed (3.8%) (Hymete et al., 2006), and both seeds (4.30%) and pods (0.83%) (Eyob et al., 2007). The refractive indices recorded for leaves (1.494) and rhizomes (1.445) were not significantly different at 25 °C, indicating that the oils obtained from the leaf and rhizome had the same level of purity and concentration.

The essential oils of korarima leaves and rhizomes contained 38 and 52 compounds identified by GC/MS, representing 93.6% and 96.4% of identified compounds respectively. Among the chemical constituents in the oil obtained from the leaves, β-caryophyllene (60.7%) and β-pinene (11.9%) were the most abundant compounds (Table 4). The oil from rhizome was

Table 4
Chemical composition of the essential oils from leaves and rhizomes of korarima

Compound	Retention indices [a]	Leaves	Rhizomes	Identification methods
α-thujene	924		0.3	MS, RI,
α-pinene	932	1.5	3.4	MS, RI, Co-inj
camphene	949		t	MS, RI
sabinene	971	0.2	0.3	MS, RI
β-pinene	978	11.9	17.6	MS, RI, Co-inj
myrcene	986	0.1	2.6	MS, RI, Co-inj
α-phellandrene	1007	0.3	7.3	MS,RI, Co-inj
α-terpinene	1016	0.1	2.7	MS, RI, Co-inj
p-cymene	1024	0.9	3.4	MS, RI, Co-inj
limonene	1028	0.4	2.3	MS, R.I, Co-inj
β-phellandrene	1030		0.9	MS, RI
1,8-cineole	1032	0.3	1.5	MS, RI, Co-inj
heptyl acetate [b]	1035		0.2	MS
(E)- β-ocimene	1043		0.5	MS, RI, Co-inj
dihydro tagetone	1050		2.2	MS, RI
γ-terpinene	1057	1.0	21.8	MS, RI, Co-inj
(E)-sabinene hydrate	1072		0.3	MS, RI
α-terpinolene	1085	0.1	1.7	MS, RI, Co-inj
n-undecane	1097		1.2	MS, RI
(Z)-sabinene hydrate	1103		0.5	MS, RI
isopulegol	1149		0.9	MS, RI
citronellal	1151		3.7	MS, RI, Co-inj
pulegol	1159		0.3	MS, RI
4-terpineol	1181		0.3	MS, RI
α-terpineol	1196	0.5	0.3	MS, RI
citronellol	1227		1.5	MS, RI, Co-inj
decanol	1270		0.5	MS, RI
dihydroedulanII	1288	0.3		MS
thymol	1292		0.2	MS,RI, Co-inj
(E)-sabinyl acetate	1298	t		
δ-elemene	1333	0.1		MS, RI
α-terpinyl acetate	1345		0.4	MS, RI
citronellyl acetate	1348		1.6	MS, RI
α-copaene	1373	0.2	0.7	MS, RI
β-bourbonene	1382	0.1		MS, RI
β-elemene	1388	0.2		MS, RI
cyperene	1400		3.7	MS, RI
longifolene	1403	0.5		MS, RI, Co-inj
α-gurjunene	1407		0.2	MS, RI
β-caryophyllene	1416	60.7	4.1	MS, RI
(E)- α-bergamotene	1431	0.3		MS, RI
α-himachalene	1443		0.2	MS, RI
α-humulene	1451	3.5	0.4	MS, RI
(E)- β-farnesene	1467	0.1	0.3	MS, RI
γ-gurjunene	1473	0.1		MS, RI
alloaromadendrene	1473		0.2	MS, RI
germacrene D	1476	0.4	0.2	MS, RI
α-selinene	1479	0.3	0.3	MS,
β-selinene	1484	0.3	0.2	MS, RI
valencene	1491	t	t	MS, RI
virdiflorene	1493	0.3	0.2	MS, RI
α-chamigrene [b]	1498	0.1	0.4	MS
(E,E)-α-farnesene	1500	0.3		MS, RI
elemol	1545		0.3	MS, RI
germacrene B	1550	0.4		MS, RI
(E)-nerolidol	1557	0.3	2.0	MS, RI
caryophyllene oxide	1579	5.7	0.5	MS, RI
bicyclogermacrene	1591		0.2	MS
virdiflorol	1607		0.2	
humulene oxide	1609	0.4		MS
10-epi-eudesmol	1611		0.2	MS, RI
α-cadinol	1656	0.5	0.2	MS, RI

Table 4 (*continued*)

Compound	Retention indices [a]	Leaves	Rhizomes	Identification methods
selin-7(11)-en-4-ol	1663	0.6	1.3	MS, RI
(Z)-α-santalol	1672	0.6		MS, RI
% Identification		93.6	96.4	

t: trace compound (<0.1 %); MS: Mass spectra; RI: Retention indices ; Co-inj: Co-injection.

[a] Compounds listed in elution order from CP-Sil 8CB column.

[b] Tentatively identified.

dominated by γ-terpinene (21.8%), β-pinene (17.6%) and α-phellandrene (7.3%).

The leaf oil was characterized by a higher content of sesquiterpene hydrocarbons, e.g. β-caryophyllene, caryophyllene oxide and α-humulene, while monoterpene hydrocarbons such as γ-terpinene, β-pinene, α-phellandrene, citronellal, α-pinene and *p*-cymene dominated essential oil of the rhizomes. No diterpene hydrocarbons were detected in the oils from the leaves and rhizomes sources. In contrast to the seed oil content of 1,8-cineole (44.3% and 39.3%) reported by Hymete et al. (2006) and Eyob et al. (2007), respectively, only minor amounts were obtained from leaves (0.3%) and rhizomes (1.5%). Among oxygen-containing structures, the sesquiterpene caryophyllene oxide (5.7%) was most abundant in the leaf oil. Oxygenated compounds such as the acyclic monoterpenes citronellal 3.7% and dihydro tagetone 2.2%, and several sesquiterpene alcohols ((*E*)-nerolidol 2.0%) were detected in the rhizome oil.

In the present study, marked differences were observed between the essential oils obtained from leaf and rhizome sources. During our study we realized that the korarima leaves were rich in β-pinene (11.9%), a monoterpene usually followed by oxygenated derivatives as a common phenomenon in other *Aframomum* species (Huguette et al., 2004). Many of the monoterpenes present in the rhizomes were absent in the leaves. The total sum of monoterpens was 17.3% in leaves and 78.5% in rhizomes, while the total sum of sesquiterpene hydrocarbons was 76.3% in leaves and 16.0% in rhizomes.

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