Advances in Natural and Applied Sciences, 3(2): 166-169, 2009
ISSN 1995-0772

ORIGINAL ARTICLE

Aromatic Plants from the Sudan: Part II. Chemical composition of the essential oil of *Xylopia aethiopica* (Dunal)A.Rich. – Existence of chemotype species

H.H. EL-Kamali, H.O. Adam

Botany Department, Faculty of Science and Technology, Omdurman Islamic University, P.O. Box # 382, Omdurman, Sudan.

H H EL-Kamali, H O Adam, Aromatic Plants from the Sudan: Part II. Chemical composition of the essential oil of *Xylopia aethiopica* (Dunal)A.Rich. – Existence of chemotype species: *Adv. in Nat. Appl. Sci., 3(2): 166-169, 2009.*

ABSTRACT

The essential oil obtained by hydrodistillation from the fruits of Sudanese native *Xylopia aethiopica* (Annonaceae) was analysed by gas chromatography-mass spectrometry GC-MS). Forty five compounds which constitute 97.43 % of the total oil were identified. The oil was dominated by monoterpene fraction which accounted for 78.58 % of the oil. The most abundant components of monoterpene hydrocarbons are alpha-pinene (11.36%), alpha-phellandrene (10.50 %), Beta-phellandrene (8.94%) and gamma- terpinene (3.19%). 4-isopropylbenzyl alcohol (16.67 %), $C_{10}H_{16}O$ (8.12%), 1,8-cineole (5.28%) and $C_{10}H_{14}O$ (2.57) are the main constituents of oxygenated monterpens. Sesquiterpene hydrocarbons contains gamma-cadinene (11.11%), $C_{15}H_{24}$ (1.73%) and copaene (0.95%) as main constituents while alpha-eudesmol (1.08%) is the most abundant oxygenated sesquiterpene.

Key words: *Xylopia aethiopica*, Annonaceae, essential oil, chemical composition, 4-isopropylbenzyl alcohol.

Introduction

Xylopia aethiopica (Dunal) A. Rich, (Annonaceae) is a medicinal plant of great repute in Africa which produces a variety of complex chemical compounds. It is commonly known as "African pepper", "Ethiopian pepper" or "Guinea pepper" and locally known as "Komba". (urkill, 1985). In Sudan and Nigeria , the fruits are used in cough medicines as well as a carminative and as spice (EL-Kamali *et al*., 2007; Oliver-ever, 1986). In Cameroon, *X. aethiopica* fruits are used in the treatment of cough , bronchitis, dysentery and female fertility (Tatsadjieu *et al*., 2003).

The essential oil of spice tree "African pepper" dried fruits from Cameroon contains more than 100 identified volatiles, and the main components are Beta-pinene (18%), terpinen-4-ol (8.9%), sabinene (7.2%), alpha-terpineol (4.1%), 1,8-cineole (2.5%), mytenol (2.4%) and kaurane derivatives (4.2%) (Jirovetz *et al*., 2005) , while Tatsadjien *et al*., 2003 fruits essential oil obtained by hydrodistillation (yield 2.5%) from plants growing in Cameroon contain Beta-pinene (18.3%), terpinen-4-ol (8.9%), sabinene (7.2%), alpha-phellandrene (7.1%), alpha-terpineol (4.1%) and trans-Beta-ocimene (3.1%). Jirovetz *et al*., 1997 gave a semblance of the aroma from the essential oil in the fruit of *X. aethiopica* from Cameroon. The oil extracted from fruits of this plant comprised of mainly monoterpenoids 1,8-cineole (15.15%) and terpinen-4-ol (6.6%) are the most abundant compounds (Aseku ad Adeniyi, 2004).

Ekundayo ,1989 reported that *X. aethiopica* fruits consist mainly of mono- and sesquiterpenoids with typical constituents being alpha-and Beta-pinene, myrcene, p-cymene, limonene, linalool and 1,8-cineole. Sesquiterpenes, elemol and guaiol and some other terpenes like p-mentha3,8-diene and p-mentha-3,8-triene were found in the essential oil of the fruit from the Republic of Benin (Ayedoun *et al*., 1996).

Tairu *et al*., 1999 showed that linalool, Beta-trans-ocimene, alpha- farnesene, alpha-pinene, Beta-pinene,

Corresponding Author: H.H. EL-Kamali, Botany Department, Faculty of Science and Technology, Omdurman Islamic University, P.O. Box # 382, Omdurman,Sudan.
E-mail: htlkamali@yahoo.com

myrtenol, Beta-phellandrene and 3-ethylphenol were the most important odorants present in the volatile oil of the fruit with linalool being the most intense giving the pepperish note, characteristic of the ground, dried, smoked fruits of *X. aethiopica*.

A number of diterpenes from *X. aethiopica* fruits have been reported (Faulkner *et al*., 1985; Rabunmi and Pieera, 1992; Harrigan *et al*., 1994).

The fruits essential oil of *X. aethiopica* showed activity against some fungi and cytotoxicity to carcinoma cells (Hep-2cell line) at 5 mg/ml concentration (Asekun and Adeniyi, 2004). The essential oil of spice tree fruits at dilution in methanol (1:5) showed moderate antibacterial activity against *Escherichia coli*, *Proteus vulgaris* and *Klebsiella pneumoniae* (EL-Kamali *et al*., 2007). Antibacterial properties in the *X. aethiopica* ethanolic extract of fruits against *E. coli, P.vulgaris* and *K. pneumoniae* was reported by Okeke *et al*., 2001.

The objectives of this study are to : (i) qualitatively and quantitatively assessing the oil components and (ii) comparing these findings with literature data on some African countries.

Materials and Methods

Plant material:

Fruits of *X. aethiopica* were collected in April 2007 from Nuba Mountains, Western Sudan. It was identified at the Department of Botany, Faculty of Science and Technology, Omdurman Islamic University.

Preparation of the essential oil:

The finely dry powdered fruits (200 grams) were subjected to Hydrodistillation using Clevenger-type apparatus (British Pharmacopaeia, 1988). The obtained oil (3 ml) was collected, and dried over anhydrous sodium sulphate and kept at 4 ºC until analysis.

GC/MS analysis

GC/MS analysis was conducted using a Shimatzu QP 2010 GC/MS instrument equipped with reference libraries.. The flow rate of helium as carrying gas was (1 ml/min). The temperature program consisted of 60 – 270 ºC, at rate of 4 ºC /min. MS were taken at ionization voltage 70 eV. Library search was carried out using Wiley GC/MS library. The individual identifications were made by the comparison of fragmentation patterns with those found in the library of the Mass spectrometer and literature (Adam, 2001).

Results and Discussion

Xylopia aethiopica growing in Sudan has not previously been subjected to any chemical investigation. The essential oil obtained from the fruits of this plant by hydrodistillation, when subjected to GC-MS analysis showed 45 identified components representing 97.43% of the total components (60 compounds) (Table 1). The GC-MS results revealed the presence of 78.58% monoterpenes (42.31% monoterpene hydrocarbons and 36.27% oxygenated monoterpenes) and 18.85% sesquiterpenes (15.88% sesquiterpene hydrocarbons and 2.97% oxygenated sesquiterpenes).

Upon comparing the composition of Sudanese oil with that of some other African origins , some variation was noted. The chemical composition of Sudanese *X. aethiopica* oil was characterized by a high content of 4-isopropylbenzyl alcohol, alpha-pinene, alpha-phellandrene and gamma-cadinene. The essential oils of various *X. aethiopica* populations from the Cameroon, Benin and Nigeria were previously studied (Table 2) and three chemotypes can be defined based on their major oil components. These chemotypes are alcohol type, ester type and Beta-pinene type. This work shows, once more, the variability of compounds of the oils of species growing in different biotypes.

Conclusion

The GC-MS analysis of a Sudanese native *Xylopia aethiopica* essential oil revealed the presence of 34 monoterpenes and 16 sesquiterpenes. This comprehensive study has highlighted the posibility of using w/w % differences between 4-isopropylbenzyl alcohol and alpha-pinene, to distinguish between Sudanese and other African *X. aethiopica* oils. This however, will require more extensive investigation. We will continue our study of the Sudanese *X. aethiopica* oils in an attempt to gain a better understanding of the secondary metabolite profile of this economically valuable plant species.

Table 1: Chemical composition of the essential oil from *Xylopia aethiopica* of Western Sudan

Compound	%	Formula	Class Type	Retention Time (RT)
delta-3-carene	2.22	$C_{10}H_{16}$	MH	11.653
alpha-pinene	11.36	$C_{10}H_{16}$	MH	11.931
camphene	0.27	$C_{10}H_{16}$	MH	12.619
unidentified	0.06	$C_{10}H_{16}O$	OM	12.819
Beta-phellandrene	8.94	$C_{10}H_{16}$	MH	13.589
Beta-pinene	0.27	$C_{10}H_{16}$	MH	14.585
unidentified	0.09	$C_{10}H_{16}$	MH	14.660
ocimene	0.02	$C_{10}H_{16}$	MH	14.711
alpha-terpinene	1.80	$C_{10}H_{16}$	MH	14.975
cymene	1.75	$C_{10}H_{14}$	MH	15.194
alpha-phellandrene	10.50	$C_{10}H_{16}$	MH	15.340
1,8-cineole	5.28	$C_{10}H_{18}O$	OM	15.392
p-ocimene	1.18	$C_{10}H_{16}$	MH	15.556
gamma-terpinene	3.19	$C_{10}H_{16}$	MH	16.062
sabinene hydrate	0.38	$C_{10}H_{18}O$	OM	16.366
2-carene	0.68	$C_{10}H_{16}$	MH	16.685
cis-p-2-menthen-1-ol	0.37	$C_{10}H_{18}O$	OM	17.049
alpha-thujone	0.05	$C_{10}H_{16}O$	OM	17.408
unidentified	0.01	$C_{10}H_{16}O$	OM	17.489
unidentified	0.40	$C_{10}H_{18}O$	OM	17.543
2,4,6-octatriene	0.04	$C_{10}H_{16}$	MH	17.594
pulegone	0.03	$C_{10}H_{16}O$	OM	17.632
l-pinocarveol	1.27	$C_{10}H_{16}O$	OM	17.869
sabinaketone	0.22	$C_9H_{14}O$		18.197
pinocarvone	0.30	$C_{10}H_{14}O$	OM	18.289
unidentified	8.12	$C_{10}H_{16}O$	OM	18.640
4-isopropylbenzyl alcohol	16.67	$C_{10}H_{14}O$	OM	18.641
unidentified	2.57	$C_{10}H_{14}O$	OM	18.907
bornyl acetate	0.08	$C_{12}H_{20}O_2$		19.319
phellandral	0.19	$C_{10}H_{16}O$	OM	19.729
unidentified	0.24	$C_{10}H_{12}O$	OM	20.325
unidentified	0.09	$C_{10}H_{16}O$	OM	20.401
terpineol	0.05	$C_{10}H_{18}O$	OM	20.466
linalool	0.09	$C_{10}H_{18}O$	OM	20.528
terpinen-4-ol	0.02	$C_{10}H_{18}O$	OM	21.004
unidentified	0.08	$C_{10}H_{16}O$	OM	21.099
delta-elemene	0.69	$C_{15}H_{24}$	SH	21.198
alpha-cubebene	0.27	$C_{15}H_{24}$	SH	21.380
ylangene	0.11	$C_{15}H_{24}$	SH	21.741
copaene	0.95	$C_{15}H_{24}$	SH	21.835
1-chloroocta-decane	0.03	$C_{18}H_{37}Cl$		22.095
Beta-caryophyllene	0.47	$C_{15}H_{24}$	SH	22.501
Beta-cubebene	0.04	$C_{15}H_{24}$	SH	22.580
humulene	0.07	$C_{15}H_{24}$	SH	22.632
unidentified	0.22	$C_{15}H_{24}$	SH	23.008
1(10),4(14),5-germacratriene	0.02	$C_{15}H_{24}$	SH	23.076
gamma-cadinene	11.11	$C_{15}H_{24}$	SH	23.356
elemol	0.73	$C_{15}H_{26}O$	OS	23.765
unidentified	1.73	$C_{15}H_{24}$	SH	24.215
guaiol	0.35	$C_{15}H_{26}O$	OS	24.413
unidentified	0.20	$C_{15}H_{24}$	SH	24.852
alpha-eudesmol	1.08	$C_{15}H_{26}O$	OS	25.427
unidentified	0.81	$C_{15}H_{26}O$	OS	25.634
phthalic acid	0.23	$C_{16}H_{22}O_4$		27.858
kaur-16-ene	0.21	$C_{20}H_{32}$		29.133
unidentified	0.04	$C_{27}H_{46}$		30.067
(+)-manoyl oxide	0.08	$C_{20}H_{34}O$		30.087
pregnane-3-17-diol	0.12	$C_{21}H_{32}O_4$		32.558
unidentified	0.04	$C_{10}H_{18}N_2O_2$		32.561
methylene bis methyl butyl-phenol	0.40	$C_{23}H_{32}O_2$		34.007

MH = Monoterpene hydrocarbons; OM = Oxygenated Monoterpenes;
SH = Sesquiterpene Hydrocarbons; OS = Oxygenated Sesquiterpenes.

Table 2: Comparison between the relative percentage of the major constituents of *X. aethiopica* fruit essential oils from different origin

Origin	Major constituents	%	Reference
Sudan	4-isopropylbenzyl alcohol	16.67	
	alpha-pinene	11.36	Present study
Cameroon	Beta-pinene	18	
	Terpinen-4-ol	8.9	Jirovetz *et al*., 2005
	Beta-pinene	18.3	
	Terpinen-4-ol	8.9	Tatsadjien *et al*., 2003
Benin	alpha- & Beta- pinene		Ayedoun *et al*., 1996
Nigeria	1,8-cineole	15.15	
	Terpinen-4-ol	6.6	Asekun and Adeniyi, 2004

Acknowledgment

We thank Department of Chemistry, Ministry of Science and Technology, Central Lab. Republic of the Sudan, for the GC/MS facilities.

References

Adams, R.P., 2001. Identification of essential oil components by gas chromatography / mass spectrometry. Allured Publishing Corp. Illinois.

Asekun, O.T. and B.A. Adeniyi, 2004. Antimicrobial and cytotoxic activities of the fruit essential oil of *Xylopia aethiopica* from Nigeria. Fitoterapia, 75(3-4): 368-370.

Ayedoun, A.M., B.S. Adeoti and P.V. Sossou, 1996. Influence of fruit conservation methods on the essential oil composition of *Xylopia aethiopica* (Dunal) A. Richard from Benin. Flav. Fragr. J., 11: 245.

British Pharmacopaeia (BP), 1988. Her Majesty s Stationaery Office, London.

Burkill, H.M., 1985. The useful plants of West Tropical Africa. Kew Royal Botanical Gardens, London.

Ekundayo, O., 1989. A review of the volatiles of the Annonaceae. J. Essent.Oil Res., 1: 223.

EL-Kamali, H.H., B.M. AbdAlla and A.Z. AL-Magboul, 2007. Antibacterial properties of some essential oils against five enterobacteriaceae species. AL-Buhuth, 11(2): 11-19.

Faulkner, D.F., D. Lebby and P.G. Waterman, 1985. Chemical studies in the Annonaceae. Part19. Further diterpenes from the stem bark of *Xylopia aethiopica*. Planta Med., 51: 354.

Harrigan, G.G., V.S. Bobzani, A.A.L. Gunatilaka and D.I.G. Kingston, 1994. Kaurane and trachylobane diterpenes from *Xylopia aethiopica*. Phytochemistry, 36: 109.

Jirovetz, L., G. Buchbauer, M.B. Ngassoum, L.T. Ngamo, O. Adjoudji, 2005. Combined investigation ofthe chemical composition of essential oils *Ocimum gratissmum* and *Xylopia aethiopica* from Cameron and their insecticidal activities against stored maize pest Sitophilus zeamais. ER Nahrung/Nutrition, 29/NR.2: 55-60.

Jirovetz, L., G. Buchbauer and M. Ngassoum, 1997. Investigation of the essential oils from the dried fruits of *Xylopia aethiopica* (West African "peppertree" and *Xylopia parviflora* from Cameroon. Ernahrung, 21: 1.

Okeke, M.I., C.U. Iroegbu, C.O. Jideofor, A.S. Okoli, C.O. Esimone, 2001. Antimicrobial activity of ethanol extracts of two indigenous Nigerian spices. Journal of Herbs, spices and medicinal plants, 8(4): 39-46.

Oliver-Bever, B., 1986. Medicinal plants in Tropical West Africa. London: Cambridge University Press.

Rabunmi, R. and E. Pieera, 1992. Japanese patent JP92-173277. Chem. Abstr., 120: 270896.

Tairu, A.O., T. Hofmann and P. Schieberle, 1999. Identification of the key Aroma compounds in dried fruits of *Xylopia aethiopica*., pp: 474-478. In : J. Janick (ed.), Perspectives on new crops and new uses. ASHS Press, Alexandria, VA.

Tatsadjieu, L.N., J.J.E. Ngang, M.B. Ngassoum, F.X. Etoa, 2003. Antibacterial and antifungal activity of *Xylopia aethiopica*, *Monodora myristica*, *Zanthoxylum xanthoxyloides* and *Zonthoxylum leprieuri* from Cameroon. Fitoterapia, 74: 469-472.