

Biflavonoids from an Ethno-Medicinal Plant *Ochna holtzii* GilgAwadh MM^{1*}, Tarus PK², Onani MO³, Machocho AK¹ and Hassanali A¹¹Department of Chemistry, Kenyatta University, P.O. Box 43844-00100, Nairobi, Kenya²Department of Chemistry and Biochemistry, University of Eldoret, P.O. 1125 – 30100, Eldoret, Kenya³Department of Chemistry, University of Western Cape, Private Bag X17, Bellville, 7535, South Africa

Abstract

Ochna holtzii Gilg is a medicinal plant used extensively at the Kenya Coast for the treatment of various ailments. From solvent extracts of the root and stem barks of *O. holtzii*, seven constituents were isolated by standard chromatographic techniques (CC, VLC, prep-TLC and Sephadex LH-20). Their structures were analyzed by MS, UV, IR, 1D and 2D NMR spectroscopy. All were found to be biflavonoids, including three novel compounds: dehydrate of lophirone C, hotzinol, and tri-O-methyl lophirone A. Crude methanol extracts of *O. holtzii* and the isolated biflavonoids were tested for antimicrobial activities against two Gram-positive bacteria, *Staphylococcus aureus* and *Bacillus subtilis*, two Gram-negative bacteria, *Salmonella typhi* and *Pseudomonas aeruginosa*, and the diploid fungus *Candida albicans*. The extracts and the isolated constituents showed varying levels of activities against the microbes. Afzelone D, lophirone A and the novel tri-O-methyl lophirone A showed strong activities against *P. aeruginosa* and *S. aureus*, with the latter being more susceptible. Calodenin B and the novel dehydrolophirone C also showed strong activities against these bacteria, but were more active against *P. aeruginosa*. However, none of these matched those of the antibiotic Chloramphenicol or the antifungal Fluconazole. This represents the first study on phytochemical and antimicrobial profiles of *O. holtzii*.

Keywords: Ochnaholtzii Gil; Ochnaceae; Biflavonoids; Dehydrolophirone C; Holtzinol, Afzelone D O-methylether

Introduction

Ochna holtzii Gilg (Ochnaceae) is one of eight plant species of the genus *Ochna* that are found in Kenya [1]. Plants in this genus are known to be rich in biflavonoids, isoflavonoids and anthranoids [2-4]. Flavonoids exhibit a wide range of biological activities, and have been of particular interest as potential anticancer [5], anti-HIV-1 [6,7] and antibacterial agents and analgesics, as well as insecticides and insect antifeedants [8]. Moreover, flavonoids are effective antioxidants and antidotes for snake bites [9], and are considered to provide protection from cardiovascular diseases [10], certain forms of cancer and age related degeneration of cell components [11]. *Ochnaholtzii* is a plant found mainly at the coastal region of Kenya. The local communities use various parts of the plant (stem and root bark) to treat different health problems, including high fever, headaches and coughs, and to soothe persistent backaches, especially in old age [12]. It is also used extensively with other plant extracts in treating microbial infections [1]. The bio-activities of this plant and associated phytochemicals have not been systematically investigated. In the present study, we undertook chromatographic separation of solvent extracts of the stem and root bark, isolated and structurally characterized some of the constituents and compared their antimicrobial and antifungal activities with those of crude extracts. Herein we report our findings.

Discussion

Compound **1** was obtained as yellow crystals from the EtOAc stem bark extract of *O. holtzii*. The UV spectrum exhibited absorption peaks at λ_{\max} 201, 223 and 274 nm, characteristic of compounds with highly conjugated system [13]. EI-MS (70eV) gave m/z at 526 [M+H]⁺ corresponding to C₃₀H₂₀O₈. This was further confirmed with NMR data including 1D NMR (¹H, ¹³C and DEPT) and 2D NMR (COSY, HSQC, HMBC and NOESY) spectra. The ¹H NMR spectrum displayed 15 signals of which thirteen (13) appeared in the aromatic region and 2 were olefinic with $J_{\text{H-H}} = 15.4$ Hz characteristic of a *trans*-configuration. The ¹³C NMR spectrum had 24 distinct signals for 30 carbon atoms, 2 of which were carbonyl carbon atoms and over 12 associated with several aromatic rings. Chemical shifts assignments were made from the analysis of ¹H-¹H COSY, HMBC and HMQC spectra. From the analysis

of the ¹H-¹H COSY spectrum, the aromatic protons were distributed into one *para*-disubstituted, three *ortho*, *para*-trisubstituted aromatic ring systems and a dehydrobenzofuran moiety. The structure of compound **1** was confirmed from the analysis of its HMBC spectrum. The ¹H and ¹³C NMR spectra of the compound closely compared with the spectral data of lophirone C [14], a compound isolated previously from *Ochnaafzelii*. The main difference was the presence of two quaternary carbon signals at δ 156.2 and 114.5 at positions α_2 and β_2 , respectively, in compound **1**, indicating a complete furene ring, while in lophirone C, the two carbon signals were aliphatic at δ 88.6 and 57.6, respectively, as shown in (Table 1). Compound **1** was named dehydrolophirone C.

Compound **2** was obtained as a yellow solid from stem bark. It gave m/z at 527 [M+H]⁺ corresponding to C₃₀H₂₂O₉ with EIMS (70eV), and MS fragmentation pattern, 1D NMR (¹H, ¹³C and DEPT) and 2D NMR (COSY, HSQC, HMBC and NOESY) spectra identical to those of lophirone K [3]. Compound **3** was obtained from the stem bark as yellow crystals. It gave m/z at 449 [M + H]⁺ with EI-MS (70eV). The molecular formula was deduced as C₂₄H₁₆O₉ and further confirmed by NMR data, including 1D NMR (¹H, ¹³C and DEPT) and 2D NMR (COSY, HSQC, HMBC and NOESY) spectra. The ¹H NMR spectrum displayed 10 signals and eight (8) of these appeared in the aromatic region. Eight of the ten signals (1D and 2D NMR) were very similar to those of α,β -unsaturated olefin moiety and B1 and B2 aromatic rings of lophirone C [14] and dehydrolophirone C. The main difference was absence in compound **3** of aromatic C-H signals corresponding to the *para*-disubstituted ring A₂ (Table 1). In addition, lack of one

*Corresponding author: Awadh MM, Department of Chemistry, Kenyatta University, P.O. Box 43844-00100, Nairobi, Kenya, Tel: 254720100520; E-mail: awadhmm99@yahoo.com

Received August 07, 2014; Accepted September 05, 2014; Published September 07, 2014

Citation: Awadh MM, Tarus PK, Onani MO, Machocho AK, Hassanali A (2014) Biflavonoids from an Ethno-Medicinal Plant *Ochna holtzii* Gilg. Nat Prod Chem Res 2: 149. doi:10.4172/2329-6836.1000149

Copyright: © 2014 Awadh MM. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Position	Compound 1		Compound 3		Compound 7	
	δ C	δ H (ppm), m*, (J (Hz))	δ C	δ H (ppm), m*, (J (Hz))	δ C	δ H (ppm), m*, (J (Hz))
B ₁ -1	114.7 s		114.7 s		117.0 s	
B ₁ -2	167.6 s		167.7 s		159.2 s	
B ₁ -3	103.8 d	6.20 (1H, d, J=2.2 Hz)	103.9 d	6.27 (1H, d, J=2.2 Hz)	103.3 d	6.69 (1H, d, J=2.2 Hz)
B ₁ -4	166.7 s		166.7 s		165.8 s	
B ₁ -5	109.3 d	6.34 (1H, dd, J=9.0, 2.2 Hz)	108.8 d	6.42 (1H, dd, J=2.2, 9.1 Hz)	116.1 d	6.83 (1H, dd, J=2.2, 8.9)
B ₁ -6	133.7 d	7.91 (1H, d, J=9.0 Hz)	133.2 d	8.10 (1H, d, J=9.1 Hz)	128.2 d	7.85 (1H, d, J=8.9 Hz)
C ₁	193.3 s		192.8s		177.1 s	
α_1	121.4 d	7.70 (1H, d, J=15.4 Hz)	119.3 d	7.72 (1H, d, J=15.4 Hz)	122.4 s	
β_1	145.2 d	7.83 (1H, d, J=15.4 Hz)	144.8 d	7.85 (1H, d, J=15.4 Hz)	157.4 d	8.22 (1H, s)
A ₁ -1	130.8 s		129.3 s		135.7 s	
A ₁ -2	122.1 d	7.71 (1H, d, J=2.0 Hz)	126.9 s		129.8 d	7.16 (2H, d, J=8.4 Hz)
A ₁ -3	132.5 s		132.1 s		116.1 d	6.56 (2H, d, J=8.4 Hz)
A ₁ -4	158.2 s		158.9 s		157.4 s	
A ₁ -5	112.8 d	7.58 (1H, d, J=8.8 Hz)	111.0 d	6.95 (1H, d, J=8.8 Hz)	116.1 d	6.56 (2H, d, J=8.4 Hz)
A ₁ -6	126.8 d	7.74 (1H, d, J=8.8, 2.0 Hz)	132.1 d	7.50 (1H, d, J=8.8 Hz)	129.8 d	7.16 (2H, d, J=8.4 Hz)
C ₂	196.1 s		196.5 s		204.8 s	
α_2	114.5 s		113.3 s		44.6 d	6.02 (1H, d, J=12.2 Hz)
β_2	156.2 s		153.3 s		54.3 d	4.70 (1H, d, J=12.2 Hz)
A ₂ -1	121.4 s				135.8 s	
A ₂ -2,6	130.6 d	7.48 (2H, d, J=8.4 Hz)			130.5 d	7.16 (2H, d, J=8.4 Hz)
A ₂ -3,5	116.7 d	6.71 (2H, d, J=8.4 Hz)			114.6 d	6.56 (2H, d, J=8.4 Hz)
A ₂ -4	160.8 s				164.5 s	
B ₂ -1	114.6 s		115.3 s		115.0 s	
B ₂ -2	167.5 s		166.1 s		166.8 s	
B ₂ -3	103.8 d	6.27 (1H, d, J=2.2 Hz)	103.3 d	6.38 (1H, d, J=2.2 Hz)	101.7 d	6.28 (1H, d, J=2.3 Hz)
B ₂ -4	167.3 s		166.1 s		168.0 s	
B ₂ -5	109.5 d	6.05 (1H, dd, J=8.8, 2.2 Hz)	109.0 d	6.49 (1H, dd, J=2.2, 8.0 Hz)	108.5 d	6.34 (1H, dd, J=2.3, 9.0)
B ₂ -6	136.7 d	7.23 (1H, d, J=8.8 Hz)	136.5 d	7.97 (1H, d, J=8.0 Hz)	134.4 d	8.14 (1H, d, J=9.0 Hz)
A ₁ -4 - OCH ₃					49.5 q	3.76 (3H, s)
A ₂ -4 - OCH ₃					56.1 q	3.76 (3H, s)
B ₂ -4 - OCH ₃					55.5 q	3.66 (3H, s)

Table 1: ¹H and ¹³C NMR data for compounds 1, 3 and 7.

aromatic proton associated with ring A₁ and presence of two doublets at δ 7.50 and 6.95 (J=8.8 Hz) showed the presence of a hydroxyl group at position 2 of the ring. These spectral features led to assignment of structure 3 for the compound which was named holtzinol.

Compound 4 was obtained as orange needles from the root bark that gave *m/z* 524 [M+H]⁺ corresponding to C₃₀H₂₀O₉ with EIMS (70eV), and MS fragmentation pattern, 1D NMR (¹H, ¹³C and DEPT) and 2D NMR (COSY, HSQC, HMBC and NOESY) spectra identical to those of calodenin B [3].

Compound 5 was obtained from the root bark that gave *m/z* 511 [M+H]⁺ corresponding to C₃₀H₂₂O₈ with EIMS (70eV), and MS fragmentation pattern, 1D NMR (¹H, ¹³C and DEPT) and 2D NMR (COSY, HSQC, HMBC and NOESY) spectra identical to those of lophirone A [15].

Compound 6 was obtained as a brown solid from stem bark that gave *m/z* 539 [M+H]⁺, corresponding to C₃₂H₂₆O₈ with EIMS (70eV), MS fragmentation pattern, 1D NMR (¹H, ¹³C and DEPT) and 2D NMR (COSY, HSQC, HMBC and NOESY) spectra identical to those of ofafzelone D [14].

Compound 7 was obtained as yellow crystals from the EtOAc root bark extract. It gave *m/z* 534 [M+H]⁺ corresponding to C₃₃H₂₈O₈, which was confirmed by NMR data, including 1D NMR (¹H, ¹³C and DEPT) and 2D NMR (COSY, HSQC, HMBC and NOESY) spectra. The ¹H NMR spectrum of 7 displayed 19 signals. Two singlets at δ 3.76

and 3.66, integrated for three and six methoxyl protons, respectively. The six protons singlet indicated that the two methoxyl groups are symmetrically positioned. The other 17 signals were very similar with respect to shifts and splitting pattern with those of lophirone A [15] and afzelone D [16] reported earlier. The existence of three methoxyl groups implied that compound 7 was tri-methoxy derivative of lophirone A, that is, lophirone A trimethyl ether (Figure 1 and Table 1).

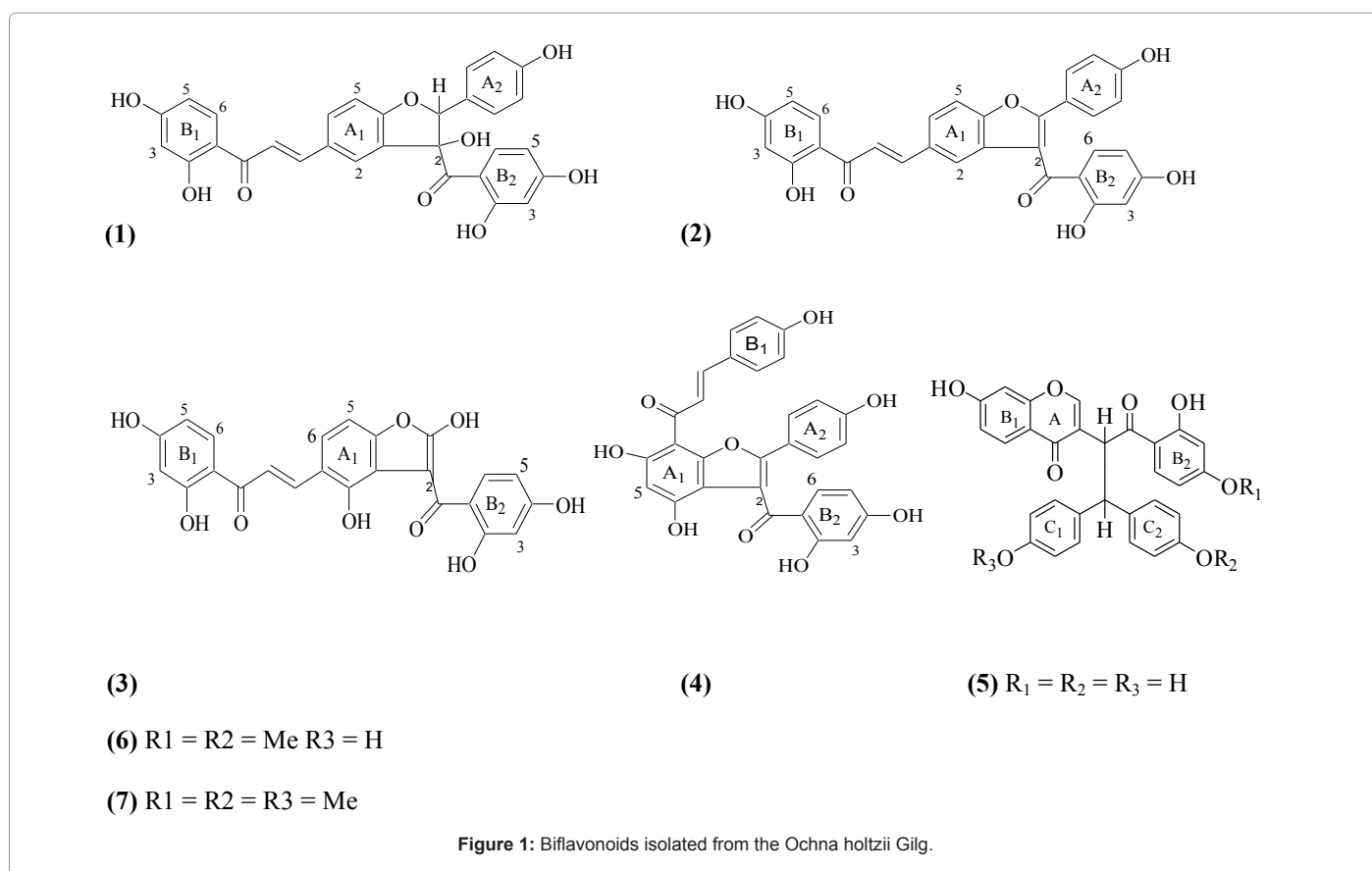
Biological activity

The root methanolic crude extract exhibited higher antimicrobial properties against *S. aureus*, *P. aeruginosa* and *B. subtilis* compared to those of the stem bark extract (Table 2). The isolated compounds showed varying levels of activities against the two gram positive and two gram negative bacteria, as well as against the diploid fungus. Lophirone A, afzelone D and lophirone A trimethyl ether also showed strong activities against these bacteria. Likewise, calodenin B and dehydrolophirone C showed also strong activities against the bacteria as well as against *C. albicans*. Further studies on related compounds that may be isolated from other *Ochna* and related plant species are expected to shed some light on the structural requirements for antimicrobial activities of this group of natural products. In addition, it would be interesting to extend the study to other bioactivities of these bioflavonoids. For example, calodenin B was previously found to exhibit cytotoxicity against breast cancer cells [17], and Lophirone A was reported to inhibit Epstein-Barr virus [18]. This biflavanoid has also been reported to exhibit potent cytotoxicity activity against

Isolate/extract	Micro-organisms									
	<i>S. aureus</i>		<i>P. aeruginosa</i>		<i>B. subtilis</i>		<i>S. typhi</i>		<i>C. albicans</i>	
	(Z-I)	MIC	(Z-I)	MIC	(Z-I)	MIC	(Z-I)	MIC	(Z-I)	MIC
Stem MeOH crude	20	500	19	1000	23	250	17	1500	13	NT
Root MeOHcrude	26	250	22	500	26	200	16	1500	14	NT
Dehydrolophirone C (1)	21	250	24	500	23	250	15	1500	18	NT
Holtzinol (3)	16	1000	14	1500	16	2000	12	1500	10	NT
Calodenin B	20	250	25	250	23	250	15	1500	22	NT
Lophirone A	24	200	21	500	25	250	15	1500	17	NT
Afzelone D	23	200	20	500	25	250	15	1500	17	NT
Tri-O-methylLophirone A (7)	23	200	20	500	24	250	14	1500	16	NT
Chloramphenicol	32	36	31	59	32	48	20	200	-	-
Fluconazole	-	-	-	-	-	-	-	-	26	72

Z-I = Zone of inhibition in mm; MIC = Minimum Inhibitory Concentration in $\mu\text{g/ml}$

Table 2: Anti-microbial activities of methanolic extracts of root and stem barks of *O. holtzii* and isolated compounds.



melanoma (UACC62), renal (TK10) and breast (MCF10) cancer cell lines [19]. Recently, Ajiboye found that lophirone C has relatively high anticancer, antimutagenic, and antioxidant activities [20]. Thus, although our results with *O. holtzii* and its constituents provide some scientific rationale for the use of this ethno-medicinal plant by the communities of the coastal region of Kenya, it also suggests the need for extending the study to other *Ochna* species and other bioactivities.

Experimental

Spectral measurements

^1H (1D, 2D COSY) and ^{13}C spectra were recorded using Varian Gemini 400 MHz (NMR) instrument using CD_3OD as solvent. Peaks on ^1H -NMR were recorded as singlet (s), doublet (d), doublet of doublet

(dd), triplet (t), quartet (q) and (or) broad (b) using internal standard TMS as reference. The ^{13}C -NMR multiplicity was determined by DEPT experiments. Chemical shifts were recorded in δ (ppm) and coupling constants, J, in Hertz (Hz). Standard sequences were used for COSY, HMQC, HMBC and NOESY experiments. IR: KBr pellets technique.

Chromatographic techniques

These include CC: silica gel 60 (0.063-0.200 mm, Merck); VLC and TLC: silica gel 60 F_{254} (Merck) precoated aluminum plates; Sephadex LH-20 used as filter gel; and *p*-anisaldehyde spray with UV-Vis was used for visualization.

Disc diffusion assay

The crude extracts and the isolated compounds were tested for

antimicrobial activities using agar diffusion technique against two Gram-positive, *Bacillus subtilis* and *Staphylococcus aureus*, two Gram-negative, *Salmonella typhi* (Type K [1]) and *Pseudomonas aeruginosa*, and a yeast *Candida albicans*. The plate diffusion method was used. Chloramphenicol was used as positive control. 14 g of nutrient agar was dissolved in 0.5l of distilled water. Round filter paper MN 615 of 9 cm diameter was punched and the paper pieces sterilized. Nutrient agar (15 ml) was poured into Petri dishes in a lamina flow apparatus under sterile conditions. Then 0.1 ml of bacterial solution was added to it. Filter paper pieces containing 100 µg of the test extract were put on Petri dish and then finally incubated at 37°C for bacteria or 30°C for fungi. The results observed were recorded by measuring the diameter of the zone of inhibition from original 6 mm.

Determination of MIC

The MIC was determined using two-fold serial dilution method in a peptone water solution for bacterial and PDA broth for yeast and fungal of the active extracts. Each tube was then inoculated with 0.1 ml of standardized bacterial suspension (1×10^8 CFU/ml) and fungal suspension (1×10^8 spores/ml). The cultures were then incubated at 37°C for 24 hours for bacteria, 48 hours for yeast and at 30°C for 72 hours for fungi. The first tube showing no growth was the MIC.

Plant materials

The stem and root barks of *O. holtzii* were collected from Arabuko-Sokoke Forest, Malindi, Kilifi County of Coast province in Kenya in April 2010. The plant was authenticated by Mr. Lucas Karimi, Department of Complementary Medicine, Kenyatta University. A voucher specimen (No. MM/002/10) was deposited at the herbarium of the Kenya National Museums, Nairobi.

Method of extraction and isolation

Air-dried stem and root barks of *O. holtzii* were separately ground to give fine powders (5.58 and 7.23 kg, respectively) and each was extracted separately using solvents of increasing polarity sequentially (starting with hexane, then DCM, followed by EtOAc and finally MeOH) for 48 hrs each with occasional swirling to ensure thorough extraction. The extracts were decanted and filtered through Whatman filter paper and the marcinate steeped in solvent again for 48 hrs. The extraction process was repeated 3 times when a clear extract was obtained. The filtrates were combined and concentrated using rotary evaporator under reduced pressure and a temperature of 45°C. A small portion of each crude extract was used for bioassays. Evaporation of the solvent from the stem bark ethyl acetate extract yielded 40 g of a dark brown residue. This extract was subjected to fractionation by Vacuum Liquid Chromatography (VLC) on silica gel with a Hexane:DCM - DCM:MeOH gradient (100:0-0:100) to yield 172×50 ml fractions. Fractions were combined after TLC comparison, which were then fractionated by column chromatography on silica gel using a gradient mixture of DCM/MeOH, starting from pure DCM, followed by 50:50 blends to pure MeOH. Fractions of 50 ml each were collected and these were subjected to further purification using Sephadex (L-20) column 1:1 (DCM:MeOH) and prep-TLC with the combined fractions using 1:1 (DCM:MeOH). Through this procedure, compound **1** was obtained. Using same procedure, other compounds isolated from the stem were lophirone **K** (**2**) [3] and afzelone **D** (**6**) [16]. A similar procedure was used with the 9 g root bark ethyl acetate extract and fractions were combined on the basis of TLC comparison and subjected to further purification. Thus, calodenin **B** (**4**) [3], lophirone **A** (**5**) [13], and compounds **3** and **7** were isolated from the root extract.

Dehydrolophirone C (1)

Yellow crystals, MP 198-200°C

IR (KBr): 2926 (br), 3356, 1620, 1512, 2962 cm^{-1} .

UV λ_{max} 201, 223 and 274 nm

¹H and ¹³C NMR: Table 1.

EI-MS m/z (%) 207 (100), 509 (1, [M+H]⁺), 433 (2), 417 (3), 389 (4), 355 (5), 281 (24), 259 (5), 241 (8), 222 (5), 191 (10), 147 (21), 133 (7), 129 (100), 112 (19), 96 (8), 83 (12), 73 (9), 55 (2).

Holtzinol (3)

Yellow crystals, MP 178-180°C

UV λ_{max} : 201, 224 and 274 nm

IR (KBr): 2926 (br), 3410, 2962, 1627, 1512 cm^{-1} .

¹H and ¹³C NMR: Table 1.

EI-MS m/z (%) 207 (100), 449 (1, [M+H]⁺), 429 (2), 390 (3), 355 (5), 281 (24), 222 (5), 259 (5), 241 (8), 191 (15), 147 (21), 133 (7), 129 (100), 112 (19), 96 (8), 83 (12), 73 (9), 71 (22), 57 (30), 55 (2).

Lophirone A trimethyl ether (7)

Yellow crystals. MP 192-194°C.

UV λ_{max} : 218, 282 nm

IR (KBr): 2926 (br), 3256, 2963, 1605, 1512 cm^{-1} .

¹H and ¹³C NMR: Table 1.

EI-MS m/z (%) 207 (100), 534 (2, [M+H]⁺), 428 (1), 355 (4), 341 (2), 306 (19), 281 (26), 214 (100), 197 (12), 183 (41), 181 (18), 163 (3), 152 (11), 149 (6), 135 (9), 133 (10), 121 (23), 108 (30), 94 (65), 77 (10), 73 (9), 65 (17), 55 (7).

Acknowledgment

We are grateful to Kenyatta University and its technical staff for providing space and some apparatus used in this work. We thank AICAD (the African Institute for Capacity Development) for partial funding of the project. We also appreciate Mr. Lucas Karimi, Department of Pharmacy and Complementary Medicine for authenticating the plant.

References

1. Beentje H (1994) Kenya trees, shrubs and lianas. National Museums of Kenya, Nairobi 368-372.
2. Khalivulla S, Reddy N, Reddy B, Reddy R, Gunasekar D et al. (2008) A new biflavanone from *Ochnalanceolata*. Natural Products Communications 3: 1487-1490.
3. Messanga BB, Tih RG, Sondengam BL, Martin MT, Bodo B (1994) Biflavonoids from *O. calodendron*. Phytochemistry 35: 791-794.
4. Sibanda S, Nyamira C, Nicoletti M, Galeffi C (1990) Ochnabianthrone; a *trans*-9,9'-bianthrone from *O. pulchra*. Phytochemistry 29: 394-396.
5. Wang B, Zhang X (2012) Inhibitory effects of Broccolini leaf flavonoids on human cancer cells. Scanning 34:1-5.
6. Mehla R, Bivalkar MS, Chauhan A (2011) A Flavonoid, Luteolin, Cripples HIV-1 by Abrogation of Tat Function. Plos one 6: e27915.
7. Reutrakul V, Ningnuek N, Pohmakotr M, Yoosook C, Napaswad C et al. (2007). Anti HIV-1 flavonoid glycosides from *Ochna integrifolia*. Planta Medica 73: 683-688.
8. Cushnie TP, Lamb AJ (2011) Recent advances in understanding the antibacterial properties of flavonoids. Int J Antimicrob Agents 38: 99-107.
9. Imam S, Gupta VC, Husain SJ (2003) Some important folk-herbal medicines used as antidotes for snake bites from tribal pockets of Atmakur forest division of Andhra Pradesh. National Symposium on emerging trends in Indian Medicinal Plants.

10. Guzey M (2013) Consumption of the dietary flavonoids and cancer.
11. Priya B, Sharma AK (2013) Anticancer potential of flavonoids: recent trends and future perspectives. Biotechnology 3: 439-459.
12. Kokwaro JO (1996) Medicinal plants of East Africa. Nairobi. E. African Literature Bureau 384.
13. Kemp W (2009) Organic spectroscopy 4: 132-183.
14. Tih AE, Ghogomu TR, Sondengam BL, Martin MT, Bodo B (1990) Biflavonoids from *Lophiraalata*. Journal of Natural Products 53: 964-965.
15. Ghogomu TR, Sondengam BL, Martin MT, Bodo B (1987) Lophirone A, a biflavonoid with unusual skeleton from *Lophiralancealata*. Tetrahedron letters 28: 2967-2968.
16. Pegnyemb DE, Ghogomu TR, Sondengam BL, Blond A, Bodo B (2003) Isolation and structure elucidation of a new isobiflavonoid from *Ochnaafzelii*. Pharmaceutical Biology 41: 92-95.
17. Tang S, Bremner P, Kortenkamp A, Schlage C, Gray AI et al. (2003) Biflavonoids with cytotoxic and antibacterial activity from *Ochnamacrocalyx*. Planta Medica 69: 247-253
18. Murakami A, Tanaka S, Ohigashi H, Irie R, Takeda N et al. (1991) Inhibitory effects of new types of biflavonoid-related polyphenols; lophirone A and lophiraic acid, on some tumor promoters-induced biological activities *in vivo* and *in vitro*. Cancer Letters 58: 101-106.
19. Ndoile MM (2012) Structure, synthesis and biological activities of biflavonoids isolated from *Ochnaserrulata* (Hochst.) Walp PhD Thesis.
20. Ajiboye TO, Yakubu MT, Oladiji AT (2014) Cytotoxic, antimutagenic, and antioxidant activities of methanolic extract and chalcone dimers (lophirones B and C) derived from *Lophiraalata* (Van Tiegh. Ex Keay) stem bark. J Evid Based Complementary Altern Med 19: 20-30.

Citation: Awadh MM, Tarus PK, Onani MO, Machocho AK, Hassanali A (2014) Biflavonoids from an Ethno-Medicinal Plant *Ochna holtzii Gilg*. Nat Prod Chem Res 2: 149. doi:[10.4172/2329-6836.1000149](https://doi.org/10.4172/2329-6836.1000149)

Submit your next manuscript and get advantages of OMICS Group submissions

Unique features:

- User friendly/feasible website-translation of your paper to 50 world's leading languages
- Audio Version of published paper
- Digital articles to share and explore

Special features:

- 350 Open Access Journals
- 30,000 editorial team
- 21 days rapid review process
- Quality and quick editorial, review and publication processing
- Indexing at PubMed (partial), Scopus, EBSCO, Index Copernicus and Google Scholar etc
- Sharing Option: Social Networking Enabled
- Authors, Reviewers and Editors rewarded with online Scientific Credits
- Better discount for your subsequent articles

Submit your manuscript at: <http://www.omicsonline.org/submission/>