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Xanthone from the Fruits of *Terminalia Arjuna*

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Abstract

2,7-dimethoxyxanthone (**1**) along with a well known compound *β*-sitosterol-3-O-*β*-D-glucopyranoside (**2**) were isolated from the methonalic extract of the fruits of *Terminalia arjuna*. Their structures were elucidated by spectroscopic (NMR and mass) analysis.

Keywords: *Terminalia arjuna*; Combretaceae; 2,7-Dimethoxyxanthone.

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1. Introduction

Terminalia arjuna Wight & Arn. (Combretaceae) is distributed in tropical and sub-tropical regions of the world. Its bark decoction is being used in the Indian subcontinent for anginal pain, hypertension, congestive heart failure, and dyslipidemia, based on the observations of ancient physicians for centuries [1-3]. Fruits and Bark of *T. arjuna* have been used as diuretic [1], tonic [4] an antioxidant [5], anticancer [6,7] hypocholesterolaemic, hypolipidemic [8-10], antiulcer [11], antiviral, antifungal and antibacterial [12-16] agents. A number of triterpenoids, saponines, tannins, cardenolides and flavonoids were reported from earlier phytochemical investigations of *T. arjuna* [17-24]. In the present study, we have isolated one xanthone identified as 2,7-dimethoxyxanthone **(1)** [Fig. 1]. Herein we report the isolation for the first time and structure elucidation of a known compound from *Terminalia arjuna*. The structure was identified on the basis of ^{1}H and ^{13}C NMR experiments and mass spectroscopic data, UV, FTIR and by comparison with the authentic data of the compound published in the literatures [25,26].

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2. Experimental

2.1. *Instruments*

NMR Spectra: *Bruker spectrometer* (^{1}H 600 & 500 MHz and ^{13}C 150 & 100 MHz) and residual protons used as internal standard. EI mass: *JEOL* (JMS 600H) mass spectroscopy. IR: *SIMADZU* FTIR (8900). UV: *HITACHI* (U-3200) spectrophotometer. Optical rotation: *JASCO* (P-2000) polarimeter. Melting point: *BUCHI* 535 digital Melting Point apparatus and were uncorrected. TLC spots were detected by UV light and fixed upon spraying ceric sulfate reagent followed by heating.

2.2. *Plant material*

The fruits of *Terminalia arjuna* W. & A. were collected from the campus of University of Rajshahi, Bangladesh, during September 2007 and was authenticated by Bangladesh National Herbarium, Dhaka, Bangladesh. A voucher specimen has been deposited (Acc. No. 32612, DACB) in the Bangladesh National Herbarium, Dhaka, Bangladesh.

2.3. *Extraction and isolation*

Air dried fruits of *T. arjuna* was powdered (18 kg) and extracted with methanol (MeOH) (60 Lx3) at room temperature for 3 days. MeOH was evaporated under vacuum to give a solid product (850 g), which was dissolved again in MeOH and partitioned with n-hexane to remove sticky and gummy materials. MeOH was evaporated under vacuum to give a residue (590 g). 200 g from this residue was suspended in H_2O and partitioned with dichloromethane (5 Lx3), ethyl acetate (5 Lx3) and n-butanol (5 Lx3) successively. The Ethyl acetate fraction (**E**, 14.5 g) was subjected to column chromatography over silica gel (30x7 cm) eluted with ethyl acetate : n-hexane and the fractions were collected at 20% ethyl acetate (E-1), 50% ethyl acetate (E-2), 75% ethyl acetate (E-3), 100% ethyl acetate (E-4) and 100% methanol (E-5). Fraction E–1 (0.6 g) was subjected to column chromatography with silica gel (25x2.5 cm) and eluted with 20% ethyl acetate : n-hexane to give a mixture which on further purification by preparative TLC over silica gel with 40% acetone : n-hexane as eluent gave a compound 2,7-dimethoxyxanthone **(1)** [Fig. 1] (2.8 mg). Known compound *β*-sitosterol-3-O-*β*-D-glucopuranoside (**2)** [Fig. 3] (21.4 mg) [27-29] was obtained from fraction E–3 by reversed-phase C18 silica gel and Sephadex LH 20 column chromatography.

2.3.1. *2,7-Dimethoxyxanthone (1)*

Physical state: pale brown amorphous solid; Yield: 2.8 mg (4.74 x 10^{-5} %); M.P.: 174-176ºC (Lit[25] mp: 172-174 ºC); EI MS (rel. int. %) *m/z*: 256(6) [M^{+}], 221(6), 169(9), 168(84), 167(7), 149(10), 138(16), 137(100), 121(14), 109(43); FAB MS (+ve) *m/z*: 257 [M + H]$^{+}$; FAB MS (-ve) *m/z*: 255 [M - H]$^{+}$; UV λ_{max} (MeOH) (log ε) nm: 216 (2.4), 249

(2.3), 302 (2.5); IR ν_{max} ($CHCl_3$) cm^{-1}: 1660, 1588, 1455, 900-650; ^1H NMR (600 MHz, solvent: $CDCl_3$, δ in ppm): Shown in Table–1; ^{13}C NMR (150 MHz, solvent: $CDCl_3$, δ in ppm): Shown in Table–1.

2.3.2. *β -sitosterol-3-O-β-D-glucopyranoside (2)*

Physical state: White amorphous solid; Yield: 21.4 mg (3.63 x 10^{-4} %); M.P.: 274-277°C (Lit.[27] : 272-274°C); $[\alpha]_D^{25}$: - 18.7° (c 0.4, MeOH); IRν_{max} (KBr) cm^{-1}: 3408, 3050, 1690, 1618, 1595, 1550; EI MS (rel. int. %) *m/z*: 414 (7), 396 (100), 381 (13), 288 (10), 255 (17), 161 (14), 147 (21), 95 (16)57 (14), 43 (16); FAB MS (-ve) *m/z*: 575 $[M - H]^+$; HR FAB MS *m/z*: 575.0210 (calcd 575.0199 for $C_{35}H_{60}O_6$); ^1H-NMR (C_5D_5N, 500 MHz) δ_H : see Table-2; ^{13}C-NMR (C_5D_5N, 100 MHz) δ_C: see Table-2.

3. Results and Discussion

Compound **1** [Fig. 1] was isolated as a brown amorphous solid with $[\alpha]_D^{25}$: -9.6º (c 2.5, CH_3OH). The molecular formula $C_{15}H_{12}O_4$ with ten degrees of unsaturation was determined by EI MS at *m/z* 256 $[M^+]$, FAB MS (positive ion mode) at *m/z* 257, FAB MS (negative ion mode) at *m/z* 255 and ^{13}C NMR (BB), DEPT 90º and DEPT 135º experiment data. IR spectrum has displayed bands for carbonyl group (1660 cm^{-1}) with aromatic ring (1588, 1455, 900-650 cm^{-1}) functionalities [30]. UV spectrum (MeOH) exhibited absorptions at 216, 249 and 302 nm characteristic of a furanocoumarin moiety [31]. ^{13}C NMR (BB), DEPT 135º and DEPT 90º experiments showed eight signals for 15 carbon atoms, which includes two methyl, six methylene and seven quaternary carbons. One quaternary carbon has showed resonance at δ_C 168.8 (C-9) for a carbonyl group. Due to plane of symmetry, all others carbons and protons in compound **1** appeared as one signal for every two symmetric carbons and protons in ^1H and ^{13}C NMR spectra, respectively. Two oxygenated quaternary carbons showed resonance at δ_C 146.2 (C-11/12), two quaternary carbons at δ_C 122.5 (C-10/13) and two oxygenated aromatic carbons at δ_C 151.7 (C-2/7). Three signals appeared at δ_C 123.6, 117.3 and 115.8 (C-3/6, C-1/8, C-4/5 res.) in aromatic region and another resonance at δ_C 52.3 (2x-OCH_3), integrated for two carbons. Two methoxy groups [δ_H/δ_C 3.82/52.3] were identified at identical positions 2 and 7, confirmed by HMBC correlations [Fig. 2] of H-1 with C-2, C-10, C-9, C-3, C-11; H-3 with C-2, C-4, C-11 and H-4 with C-3, C-2, C-11. Methoxy protons have exhibited HMBC correlation with C-3 atoms.

Compound **1** showed two aromatic protons at δ_H 7.41 as a doublet (*J*=2.4 Hz, H-1 and H-8), other two aromatic protons at δ_H 7.39 as a doublet of doublet (*J*=2.4, 9.0 Hz, H-3 and H-6, and another two aromatic protons at δ_H 6.79 as a doublet (*J*=9.0 Hz, H-4 and H-5). A signal appeared as singlet at δ_H 3.82 integrated for six protons were assigned for two methoxy groups. Thus, the structure of compound **1** was established as 2,7-dimthoxyxanthone which was synthesized by Menéndez and Mahfouz and their co-worker [25,26]. Compound **1** was isolated first time from any natural source.

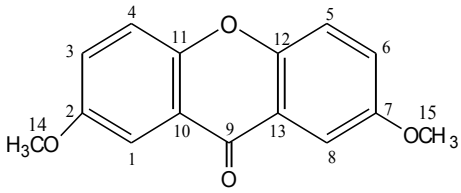

Fig. 1. 2,7-Dimehoxyxanthone **(1)**.

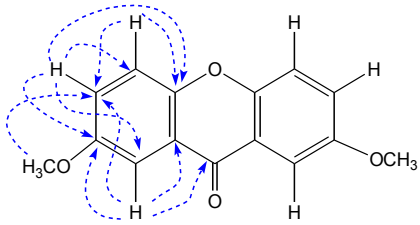

Fig. 2. HMBC correlation of **1.**

Table 1. ^{1}H and ^{13}C NMR data (600 & 150 MHz) of compound **1** (solvent: $CDCl_3$, δ in ppm).

C No.	Mult.	δ_C	δ_H (m, *J* Hz)
C1/C8	CH	117.3	7.41 (d, J = 2.4 Hz)
C2/C7	C	151.7	-
C3/C6	CH	123.6	7.39 (dd, J = 2.4, 9.0 Hz)
C4/C5	CH	115.8	6.79 (d, J = 9.0 Hz)
C9	C	168.8	-
C10/C13	C	122.5	-
C11/C12	C	146.2	-
C14/C15	CH_3	52.3	3.82 (s)

Known compound *β*-sitosterol-3-O-*β*-D-glucopyranoside (**2**) [Fig. 3] showed melting point 274-277°C (in Lit.[27]: 272-274°C), and FAB MS (-ve ion mode) showed peak at *m/z* 575 $[M-H]^+$, HR FAB MS showed peak at *m/z* 575.0210 (calcd 575.0199 for $C_{35}H_{60}O_6$) was compared with the reported data [27-29] and found similar.

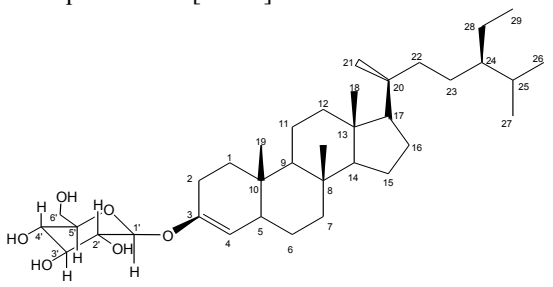

Fig. 3. *β*-Sitosterol-3-O-*β*-D-glucopyranoside **(2).**

Table 2. ^{1}H and ^{13}C NMR data of compound **2** (solvent: C_5D_5N, δ in ppm).

			2 †		Ref [27] ‡
C No.	Mult.	δ_C	δ_H (m, J Hz)	δ_C	δ_H (m, J Hz)
1	CH_2	37.4	2.72 (dd, 11.5, 2.5 Hz)	36.85	1.25 (m,2H)
2	CH_2	30.1	2.21,1.72 (d, 11.5 Hz)	29.12	1.33 (m,2H)
3	CH	78.5	4.29, 3.99 (dd, 8.0 Hz)	78.61	3.13 (m,1H)
4	CH_2	39.3	2.46 (dd, 11.0 Hz)	42.12	2.14 (m,2H)
5	C	140.8	-	139.98	-
6	CH	138.8	5.05 (tbr, 2.5 Hz)	121.54	5.09 (brs, 1H)
7	CH_2	32.1	1.52, 1.88 (overlap)	31.41	1.73 (m, 2H)
8	CH	32.0	1.35 (overlap)	31.46	1.22 (m,1H)
9	CH	50.2	0.89 (s)	49.83	1.22 (m,1H)

		2 †		Ref [27] ‡	
C No.	Mult.	δ_C	δ_H (m, J Hz)	δ_C	δ_H (m, J Hz)
10	C	36.9	-	36.27	-
11	CH_2	21.2	1.38, 1.05 (overlap)	20.21	1.33 (m,2H)
12	CH2	39.9	1.94, 1.05 (overlap)	38.20	1.33 (m, 2H)
13	C	42.4	-	41.88	-
14	CH	56.7	0.92 (overlap)	56.36	1.22 (m,1H)
15	CH_2	24.5	1.55, 1.03 (overlap)	23.79	1.73 (m, 2H)
16	CH_2	28.5	1.81, 1.23 (overlap)	27.76	1.73 (m, 2H)
17	CH	56.1	1.07	55.66	1.73 (m, 2H)
18	CH_3	11.9	0.63 (s)	11.27	0.62 (s, 3H)
19	CH_3	19.4	0.88 (d)	19.10	0.94 (s, 3H)
20	CH	36.3	1.36 (overlap)	35.70	1.32 (m, 1H)
21	CH_3	18.9	0.92 (d, 6.5 Hz)	18.69	0.84 (d, 3H, J=6.3 Hz)
22	CH_2	34.1	1.38,1.06 (o)	33.51	1.73 (m, 2H)
23	CH_2	26.2	1.21 (o)	25.64	1.73 (m, 2H)
24	CH	45.9	0.97 (o)	45.49	1.12 (m, 1H)
25	CH	29.3	1.70 (o)	28.74	2.14 (m, 1H)
26	CH_3	19.1	0.83 (s)	18.69	0.75 (d, 3H, J=7.7 Hz)
27	CH_3	19.9	0.89 (s)	18.35	0.73 (d, 3H, J=1.6 Hz)
28	CH_2	23.3	1.26 (o)	22.60	1.33 (m, 2H)
29	CH_3	12.1	0.87 (o)	12.29	0.77 (t, 3H, J=6.9 Hz)
1′	CH	102.5	5.33 (d, 7.5 Hz)	100.74	4.11 (d, 1H, J=7.8 Hz)
2′	CH	78.6	4.31 (d, 9.0 Hz)	73.21	3.41 (m, 1H)
3′	CH	78.0	3.99 (o)	76.18	3.41 (m, 1H)
4′	CH	71.6	4.29 (d, 8.0 Hz)	69.90	3.41 (m, 1H)
5′	CH	75.3	4.06 (t, 8 Hz)	75.62	3.06 (m, 1H)
6′	CH_2	62.7	4.41, 4.56 (d, 9.5, 5.0Hz)	61.36	2.94 (m, 2H)

^1H & ^{13}C: † 500 & 100 MHz, Solvent C_5D_5N; ‡ 400 & 100 MHz, Solvent: $CDCl_3$

4. Conclusion

Synthesized compound **1** was isolated from the methanolic extract of the fruits of *Terminalia arjuna* and the structure was identified as 2,7-dimthoxyxanthone which was isolated first time from any natural source, confirmed by SciFinder®. Compound **2** showed the physical and spectral data similar to the reported.

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