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XANTHONES FROM *HYPERICUM JAPONICUM* AND *H. HENRYI*

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Key Word Index—*Hypericum japonicum*; *H. henryi*; Guttiferae; xanthone; coagulant activity; chemotaxonomy; 1,5-dihydroxyxanthone-6-*O*-*β*-D-glucoside; bijaponicaxanthone; 1,3,5,6-tetrahydroxy-4-prenylxanthone.

Abstract—From the aerial part of *Hypericum japonicum*, one new xanthone glycoside, 1,5-dihydroxyxanthone-6-*O*-*β*-D-glucoside, one novel dimer xanthone, bijaponicaxanthone, and the first natural prenylated xanthone, 1,3,5,6-tetrahydroxy-4-prenylxanthone, were isolated together with the four known xanthones, 1,5,6-trihydroxyxanthone, isojacereubin, 6-deoxyisojacareubin and 4′,5′-dihydro-1,5,6-trihydroxy-4′,4′,5′-trimethylfurano (2′,3′:4,5) xanthone. Five previously known xanthones, kielcorin, cadensin, 1,7,-dihydroxyxanthone, 1,5-dihydroxy-4-methoxyxanthone and 1,2,5-trihydroxyxanthone were also found in the dichoromethane extract of the stems and leaves of *H. henryi*. Their structures were elucidated by spectroscopic and chemical methods. Some of the compounds from *H. japonicum* were found to exert an interesting coagulant activity in an *in vitro* test. The chemotaxonomic value of xanthones is discussed briefly.

INTRODUCTION

Hypericum is a large genus of herbs or shrubs, which occurs widely in temperate regions of the world. In China, there are 55 species and eight subspecies and half of them have been used in Chinese herbal medicine, mainly for the treatment of infectious hepatitis. The recent surge of interest in chemistry of the genus has led to the isolation of more than 100 components from *ca* 20 species, with different biological activities. In particular, extracts of *H. perforatum* are now widely used in Europe as drugs for the treatment of depression [1–3].

Hypericum japonicum is a Chinese medicinal plant used for the treatment of several bacterial diseases, infectious hepatitis, gastrointestinal disorder and tumors [4]. Ishiguro *et al*. reported the isolation of 13 phloroglucinol derivatives [4–8], five flavonoids [9, 10], a peptide [11], a lactone [12] and two xanthones [10, 13]. Previously, we have reported the isolation and structural determination of two chromone glycosides and 11 flavonoids [14] from the ethyl acetate and acetone extracts of *H. japonicum*. Further investigation of the dichoromethane, ethyl acetate and acetone extracts of this species has led to the isolation of seven xanthones. Two of them are new compounds; a prenylated xanthones was also isolated for the first time from a natural source. Some of the isolated compounds showed good coagulant bioactivity *in vitro*.

Hypericum henryi, an endemic plant in China, is a Chinese folk medicine used in treatment of infectious hepatitis. Based on available literature, no chemical investigation has been carried out on this plant. In continuation of our study on *Hypericum*, oriented to obtain biologically active compounds and influenced by a chemotaxonomic interest in this genus, we investigated the chemical constituents in the dichoromethane extract of this species and isolated five unusual oxygenated xanthones, including two xanthonolignoids and three simple oxygenated xanthones.

RESULTS AND DISCUSSION

The ethanol extract of dried aerial parts of *H. japonicum* was extracted with petrol, dichoromethane, ethyl acetate, acetone and methanol in a Soxhlet. The dichoromethane, ethyl acetate and acetone fractions were purified and seven xanthones (**1–7**) were obtained, two of which are new compounds (**1** and **3**), together with a xanthone isolated for the first time from a natural source (**6**). Leaves and stems of *H. henryi*

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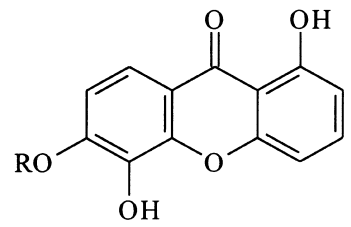

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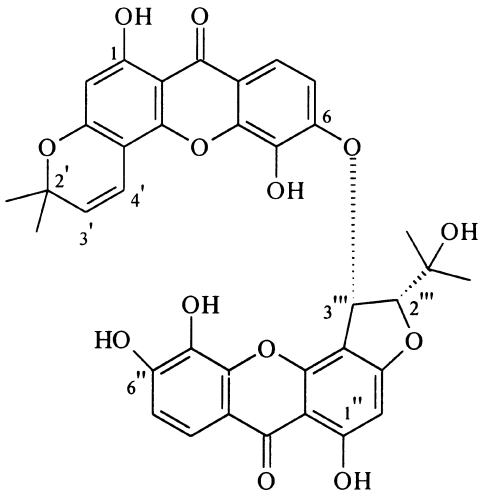
2 R=H



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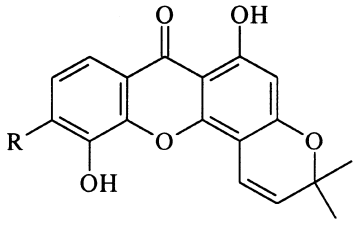
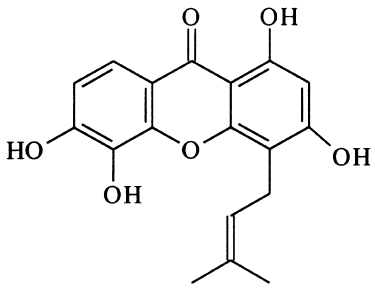


4 R=OH
5 R=H



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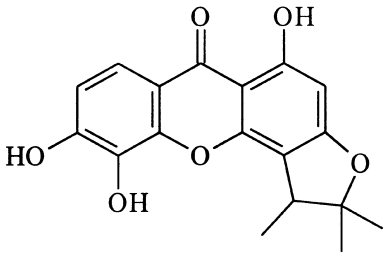

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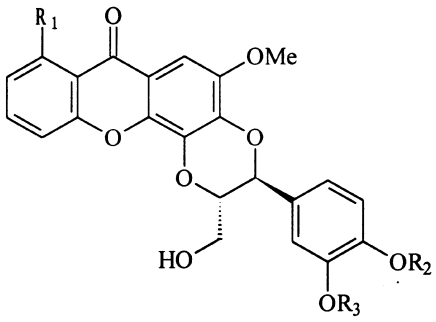
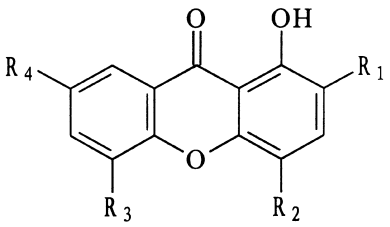


8 R_1=R_2=H, R_3=Me
9 R_1=OH, R_2=Me, R_3=H



10 R_1=R_2=R_3=H, R_4=OH
11 R_1=R_3=H, R_2=OMe, R_4=OH
12 R_1=R_3=OH, R_2=R_4=H

were extracted successively with dichoromethane and purified to give five xanthones (**8–12**).

Compound **1**, had the molecular formula $C_{19}H_{18}O_{10}$ based on EI-mass spectrometry (*m/z* 244 $[M]^+$ of aglycone), negative FAB-mass spectrometry *m/z* 405 [M-H],[1] H NMR and ^{13}C NMR. Its UV (MeOH) spectrum (242 and 312 nm) showed the occurrence of a xanthone nucleus [15]. The IR (KBr) spectrum showed absorption at 3420 (OH), 2960, 1650 (α, β-unsaturated C=O), 1630, 1610, 1580 and 1465 cm^{-1}. In the ^1H NMR (500 MHz, DMSO-d_6), the aromatic protons at δ 7.71 (1H, *t*, *J*=8.3 Hz), 7.62 (1H, *d*, *J*=9.0 Hz), 7.30

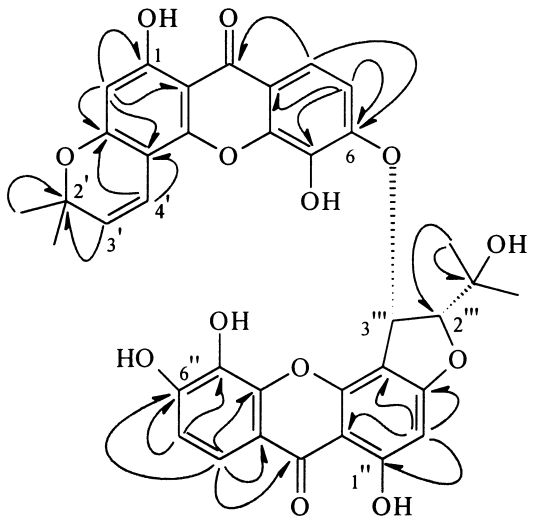
Table 1. ^{1}H and ^{13}C NMR spectral data for compounds **1** and **2** (δ, J values in Hz)[1]

	1		**2**	
	C	**H**	**C**	**H**
1	161.0		161.4	
2	110.0	6.80 *d* (8.3)	109.7	6.76 *d* (7.8)
3	137.0	7.71 *t* (8.3)	136.5	7.66 *t* (7.8)
4	107.1	7.09 *d* (8.3)	106.4	6.96 *d* (7.8)
4a	155.9		155.7	
4b	145.6		145.6	
5	137.0		132.5	
6	150.6		152.5	
7	112.7	7.30 *d* (9.0)	113.4	7.03 *d* (8.7)
8	115.4	7.62 *d* (9.0)	116.1	7.55 *d* (8.7)
8a	115.4		113.0	
9	181.1		181.1	
9a	107.8		107.5	
1′	101.4	5.00 *d* (7.7)		
2′	73.2			
3′	75.8			
4′	69.7			
5′	77.3			
6′	60.6			

Recorded in DMSO-d_6.

(1H, *d*, $J=9.0$ Hz), 7.09 (1H, *d*, $J=8.3$ Hz) and 6.80 (1H, *d*, $J=8.3$ Hz) were very similar to those of 1, 5, 6-trihydroxyxanthone and should, therefore be assigned to H-3, H-7, H-8, H-4 and H-2, respectively [16, 17]. Acidic hydrolysis of **1** yielded glucose and 1,5,6-trihydroxyxanthone (**2**) identified by co-TLC with authentic samples. The anomeric proton at δ 5.0 (1H, *d*, $J=7.7$ Hz, H-1′) in its ^{1}H NMR also indicated the β-configuration of glucose. In the ^{1}H NMR of **1**, a characteristic glycosylation shift ($+0.27$ ppm) was observed for H-7, suggesting the location of the glucose moiety to be C-6 [18]. Thus, taking into consideration all the above data and analysis, the structure of **1** was established as 1,5-dihydroxyxanthone-6-*O*-β-D-glucoside (Table 1).

Compound **3**, gave the molecular formula $C_{36}H_{28}O_{13}$ based on its FAB-mass spectrum, ^{1}H NMR (300 MHz, DMSO-d_6 and DMSO-d_6+D_2O), ^{13}C NMR and DEPT. Its UV (MeOH) spectrum (250 and 322 nm) showed the occurrence of a xanthone nucleus [15]. Its IR (KBr) spectrum showed absorption at 3430, 1670, 1665, 1610, 1570, 1510 and 1430 cm^{-1}. The EI-MS spectrum of **3** showed two groups of fragments at m/z 326, 311 and m/z 284, indicating that it possessed two similar prenylated xanthones combining its ^{1}H NMR and ^{13}C NMR. One xanthone fragment resembled that of the known compound isojacareubin (**4**). The AB-system downfield protons at δ 6.78 (1H, *d*, $J=10.0$ Hz, H-4′), 5.83 (1H, *d*, $J=10.0$ Hz, H-3′) and the six proton singlet at δ 1.46 (2′-Me's) suggested the presence of a 2,2-dimethylpyran. The AB-system aromatic proton signals at δ 7.63 (1H, *d*, $J=8.5$ Hz) and 7.03 (1H, *d*, $J=8.5$ Hz) were due to H-8 and H-7, respectively, whereas the aromatic singlet at δ 6.23 (1H) were due to C-2 [19]. The other group of aromatic proton signals at δ 7.51 (1H, *d*, $J=8.7$ Hz, H-8″), 6.92 (1H, *d*, $J=8.7$ Hz, H-7″) and 6.29 (1H, *s*, H-2″) were similar to those of the xanthone fragment mentioned above [19]. Combining its DEPT and 2D NMR, the upfield proton signals at δ 5.94 (1H, *d*, $J=7.5$ Hz, H-2‴), 5.04 (1H, *d*, $J=7.5$ Hz, H-3‴), 4.37 (1H, *brs*, HO-4‴) (disappeared in D_2O) and 1.29, 1.26 (each 3H, *s*, 4‴-Me's) indicated the presence of a 2,3-dihydro-2-(1-hydroxy-1-methylethyl)-3-oxyl-furan ring [20–22]. A *cis*-configuration of the dihydrofuran protons in **3** was inferred from their coupling constant ($J=7.3$ Hz) [20–22]. Furthermore, the structure is in agreement with its EI-mass spectrum (m/z 284). In comparison with those of isojacareubin (**4**), the downfield shift ($+0.11$ ppm) for H-7 and the upfield shift (-3.0 ppm) for C-6 indicated a C-6-O-C-3‴ linkage [18]. Thus, **3** was established as 6-[1″,5″,6″-trihydroxy-2‴-(α-hydroxy-α-methylethyl)-2‴,3‴-dihydrofuran (5‴,4‴,3″,4″) xanthone-3‴-oxyl]-3,4-(2′,2′-dimethylpyran)-1,5-dihydroxy-xanthone, named as bijaponicaxanthone.



Scheme 1.

From its HMQC and HMBC (Scheme 1), all of the carbon signals were assigned (Table 2).

Compound **6**, was assigned the molecular formula $C_{18}H_{16}O_6$ based on its EI-mass spectrum $[M]^+$ *m/z* 328) and ^1H NMR. The UV spectrum (MeOH, 248, 286 and 322 nm) was suggestive of a xanthone [2]. In the ^1H NMR (300 MHz, DMSO-d_6) spectrum, the proton signals at δ 5.25 (1H, *t*, $J=6.9$ Hz, H-2′), 3.44 (2H, *d*, $J=6.9$ Hz, H-1′), 1.77, 1.60 (each 3H, Me's) clearly indicated the presence of a prenyl group [23]. Two downfield *ortho*-coupled aromatic proton signals at δ 7.48 and 6.91 (each 1H, *d*, $J=8.7$ Hz) were assigned to H-8 and H-7 [19], and a singlet at δ 6.23 (1H) to H-2. Thus, **6**, was established as 1,3,5,6,-tetrahydroxy-4-prenylxanthone, which is reported from nature for the first time [24].

Compounds **2**, **4**, **5**, **7**–**12** were identified as 1,5,6-trihydroxyxanthone (**2**), isojacareubin (**4**), deoxyisojacareubin (**5**), 4,5,-dihydro-1,5,6-trihydroxy-4,4,5-trimethylfurano (2′3′:4,5) xanthone (**7**), kielcorin (**8**), cadesin A (**9**), 1,7-dihydroxyxanthone (**10**), 1,7-dihydroxy-4-methoxyxanthone (**11**) and 1,2,5-trihydroxyxanthone (**12**), respectively, by spectroscopic analysis.

The distribution of xanthones is very restricted in occurrence. They are obtained mainly from two unrelated families Clusiaceae (Guttiferae) and Gentianaceae; their potential taxonomic value is restricted only to these families [25–27]. Simple oxygenated xanthones occur in both families and are generally less oxygenated in the Clusiaceae. Most of the xanthones from the Clusiaceae do not have more than four oxygenations. However, pentaoxygenated xanthones are very common in the Gentianaceae. Prenylated xanthones are widely distributed in Clusiaceae, but not known in Gentianaceae and, whereas glycosylxanthones are common in Gentianaceae, only a few have been reported in Clusiaceae [25–27]. In addition, some of xanthones have been also isolated from the Moraceae, Polygalaceae and some ferns in the Polypodiaceae [25, 28].

More than 200 xanthones, including simple oxygenated xanthones, prenylated xanthones, xanthonolignoids and benzophenones, have been reported in Clusiaceae. According to the oxygenation patterns, the xanthones with 1,3-dioxygenation in A-ring, *e.g.* 1,3,5-tri, 1,3,7-tri, 1,3,5,6-penta and 1,3,6,7-pentaoxygenation, being of primary chemical character, are common in the Clusiaceae. The other unusual oxygenation patterns, being of some systematic significance are only confined to certain plant taxa in the Clusiaceae [25, 28]. The species, *H. japonicum* and *H. henryi*, are classified in two different Sections, Spachium (R. Keller) N. Roboson and Ascyreia Choisy, respectively. The xanthones in *H. henryi*, being of unusual oxygenation patterns, *e.g.* 1,2,5-tri, 1,4,7-tri, 2,3,4-tri and 1,5,6,7-pentaoxygenation, are significantly different from those in *H. japonicum*. In addition, *H. henryi* shows the absence of prenylated xanthones. The chemotaxonomic value of xanthones in *Hypericum* may become clearer as more species are investigated.

Xanthonolignoids are biogenatically thought to be formed *via* coupling of a C_6-C_3 unit with *ortho*-dihydroxyxanthone. As a fairly uncommon group of natural products, a few structures have been described only in the Kielmeyeroideae and Hypericoideae [15, 25], showing a link of the two subfamilies. The subfamily Hypericoideae has been treated by some taxonomists, such as Hutchinson and Takhtajan, as a separate family-Hypericaceae. However, more recently classifications by Cronquist, Dahlgren and Thorne treated Clusiaceae still retained the broad concept, in which the Hypericoideae were not separated at the family level [25]. The distribution of xanthonolignoids in *H. henryi* has further supported its inclusion in the Clusiaceae.

The compounds from *H. japonicum* were tested for their coagulant activity in *in vitro* system. Compound **1** showed activity of promoting coagulation of PT, and **4** showed anticoagulation of APTT.

EXPERIMENTAL

General

All mps are uncorr. NMR were recorded on a Bruker AM 500 or a Bruker DMX-300 spectrometer with TMS as int. standard. Chromatography separations were carried out on silica gel, polyamide and Sephadex LH-20, and TLC on silica gel G and polyamide film.

Plant material

Aerial parts of *H. japonicum* Thunb. ex Murray were collected from Anhui province, China, in Sept., 1994, and leaves and stems of *H. henryi* Levl. et Wan. from Yunnan province, China, in Oct., 1995. Voucher

Table 2. ^{1}H and ^{13}C NMR spectral data for compounds **3** and **4** (δ, J values in Hz)[2]

	3		**4**	
	C	**H**	**C**	**H**
1	162.3		162.7	
2	98.6	6.23 *s*	98.7	6.19 *s*
3	159.8		160.0	
4	102.6		102.6	
4a	151.0		151.6	
4b	145.5		146.4	
5	131.7		132.9	
6	149.7		152.7	
7	113.7	7.03 *d* (8.5)	115.4	6.92 *d* (7.7)
8	116.8	7.62 *d* (8.5)	116.5	7.54 *d* (7.7)
8a	113.7		113.3	
9	179.6		180.4	
9a	100.7		101.3	
2′	78.3		78.5	
3′	128.2	5.83 *d* (10.0)	127.6	5.78 *d* (10.2)
4′	113.6	6.78 *d* (10.0)	113.7	7.07 *d* (10.2)
2′-Me's	27.8	1.46 *s*	28.2	1.44 *s*
1″	162.9			
2″	97.7	6.29 *s*		
3″	159.8			
4″	101.4			
4″a	151.0			
4″b	146.0			
5″	132.7			
6″	152.0			
7″	113.1	6.92 *d* (8.7)		
8″	115.7	7.51 *d* (8.7)		
9″	179.9			
9″a	103.0			
2‴	79.2	5.04 *d* (7.5)		
3‴	71.0	5.94 *d* (7.5)		
4‴	70.3			
4‴-Me's	27.8	1.29 *s*		
	24.9	1.26 *s*		
1-OH	13.33 *s*		13.29 *s*	
1″-OH	13.05 *s*			
4‴-OH	4.37 *brs*			
5,5″,6″-OH's	**11.30, 10.38, 9.00** *brs*			

Measured in DMSO-d_6.

specimens are deposited in the Institute of Medicinal Plant Development, Chinese Academy of Medical Sciences, Beijing, P. R. China.

Extraction and isolation

Air-dried aerial parts of *H. japonicum* (12 kg) were extracted $\times 3$ with 95% EtOH. The EtOH extract (1.1 kg) was re-extracted successively with petrol, CH_2Cl_2, EtOAc, Me_2CO and MeOH in a Soxhlet extractor. The CH_2Cl_2 fr. (80 g) was chromatographed on a silica gel column using a step-gradient petrol-EtOAc and gave seven frs. 1–7. Fr. 4 was chromatographed on polyamide (MeOH-H_2O) to give **5** (30 mg). Fr. 7 was rechromatographed on silica gel

(petrol-Me_2CO and $CHCl_3$-MeOH) and **4** (20 mg) was obtained. The EtOAc fr. (200 g) were chromatographed on silica gel column using a step-gradient, $CHCl_3$-MeOH and ten frs were obtained (1–10) Fr. 2 was chromatographed on polyamide (MeOH-H_2O) followed by purification on Sephadex LH-20 (MeOH), to give **2** (40 mg) and **7** (40 mg). Fr. 3 was rechromatographed on polyamide (MeOH-H_2O) and Sephadex LH-20 (MeOH) to give **6** (30 mg). Fr. 4 was rechromatographed repeatedly (silica gel and polyamide, $CHCl_3$-MeOH) and **3** (70 mg) was obtained. The Me_2CO fr. (300 g) was chromatographed on a silica gel column using a step-gradient of $CHCl_3$-MeOH and 15 frs (1–15) were obtained. Rechromatography of fr. 7 on polyamide ($CHCl_3$-MeOH) and Sephadex LH-20 (MeOH) gave **1** (20 mg).

Air-dried leaves and stems of *H. henryi* (5 kg) were extracted $\times 3$ with CH_2Cl_2. The CH_2Cl_2 extract (30 g) were chromatographed on a polyamide column using a step-gradient of MeOH-H_2O and 10 frs (1–10) were obtained. After recrystallization, **8** (200 mg) was obtained from fr. 2. Fr. 4 was chromatographed on polyamide (petrol-$CHCl_3$-MeOH), followed by gel filtration on Sephadex LH-20 (MeOH) to give **10** (20 mg), **11** (5 mg) and **12** (10 mg). Fr. 5 was chromatographed on Sephadex LH-20 (MeOH) and **9** (10 mg) was obtained.

1,5-*Dihydroxyanthone*-6-O-*β*-D-*glucoside* (**1**)

Yellow amorphous power, mp 265–266°. IR ν_{max}^{KBr} cm^{-1}: 3420 (HO), 2960, 1650 (α, *β*-unsaturated C═O), 1630, 1610, 1580, 1465, 1295, 1235, 975. UV λ_{max}^{MeOH} nm: 242, 312; +NaOMe: 242, 260, 308, 340; +$AlCl_3$: 230, 256, 358; +$AlCl_3$+HCl: 230, 352, 346; +NaOAc: 238, 260, 306, 334; +NaOAc+H_3BO_3: 240, 308. EI-MS *m*/*z* (rel. int.): 244 [M-glu]$^+$ (100), 216 [M-glu-C═O]$^+$ 187(6.2), 108 (8.7), 92 (7.0), 91 (6.6); FAB-MS (*m*/*z*): 405 [M-H]$^+$, 243 [M-glu-H]$^+$. ^{1}H and ^{13}C NMR: Table 1.

1,5,6-*Trihydroxyxanthone* (**2**)

Yellow amorphous power, mp 274–276°. IR ν_{max}^{KBr} cm^{-1}: 3400 (HO), 1650 (α, *β*-unsaturated C═O), 1610, 1580, 1460, 1380, 1270. UV λ_{max}^{MeOH} nm: 246, 326; +NaOMe: 235, 274 sh, 364; +$AlCl_3$: 252 sh, 275, 390; +$AlCl_3$+HCl: 230, 256, 354; +NaOAc: 272, 352; +NaOAc+H_3BO_3: 256 sh, 342. ^{1}H NMR identical to ref [16]. ^{1}H and ^{13}C NMR: Tab. 1. EI-MS *m*/*z* (rel. int.): 244 [M$^+$] (100), 216 [M-C═O]$^+$ (11.4), 187 (9.5), 108 (9.5), 92 (10.2).

Bijaponicaxanthone (**3**)

Yellow amorphous power, mp 248–250°. IR ν_{max}^{KBr} cm^{-1}: 3430, 3220 (HO), 1670, 1665 (α, *β*-unsaturated C═O), 1610, 1570, 1510, 1430, 1325, 1275, 1180, 1120. UV λ_{max}^{MeOH} nm: 250, 322; +NaOMe: 254, 270sh, 300sh, 374; +$AlCl_3$: 260, 274sh, 354: +$AlCl_3$+HCl: 256, 276sh, 346; +NaOAc: 252, 350; +NaOAc+H_3BO_3: 254, 326. EI-MS *m*/*z* (rel. int.): 326 (14.7), 311 (100), 284 (16.7), 156 (9.6). FAB-MS *m*/*z* (rel. int.): 669 [M$^+$ − 1], 326, 311, 285. ^{1}H and ^{13}C NMR: Tab. 2.

Isojacareubin (**4**)

Yellow amorphous powder, mp > 250°. IR ν_{max}^{KBr} cm^{-1}: 3320 (HO), 1650 (α, *β*-unsaturated C═O), 1585, 1525, 1215, 1170, 1120. UV λ_{max}^{MeOH} nm: 252, 298sh, 326; +NaOMe: 260, 368; +$AlCl_3$: 274, 386; +$AlCl_3$+HCl: 256, 274, 300 sh, 350; +NaOAc: 266, 300sh, 370; +NaOAc+H_3BO_3: 260, 296, 354. ^{1}H and ^{13}C NMR in agreement with ref. [19], see Tab. 2. [M$^+$], 311 [M-Me]$^+$ (100), 156 (10.7).

6-*Deoxyisojacareubin* (**5**)

Yellow needles, mp > 250°. IR, UV. and ^{1}H NMR in agreement with refs [29, 30]. EI-MS *m*/*z* (rel. int.): 310 [M$^+$] (14.6), 295 [M-Me]$^+$ (100), 148 (12.3), 128 (2.5), 97 (4.6), 83 (4.7), 77 (4.0), 73 (5.1).

1,3,5,6-*Tetrahydroxy*-4-*prenylxanthone* (**6**)

Pale yellow crystals. IR ν_{max}^{KBr} cm^{-1}: 3420 (HO), 1660 (α, *β*-unsaturated C═O), 1600, 1440, 1350, 990. UV λ_{max}^{MeOH} nm: 248, 286, 322; +NaOMe: 258, 298sh, 378; +$AlCl_3$: 266, 290sh, 386; +$AlCl_3$+HCl: 254, 346; +NaOAc: 250, 290sh, 358; +NaOAc+H_3BO_3: 254, 290sh, 344. ^{1}H NMR (300 MHz, DMSO-d_6): *δ* 13.09 (1H, *s*, chelated HO-1), 11.03, 10.84, 9.23 (each 1H, *s*, HO-5, 6, 3), 7.48, 6.91 (each 1H, *d*, *J* = 8.7 Hz, H-8, 7), 6.23 (1H, *s*, H-2), 5.25 (1H, *t*, *J* = 6.9 Hz, H-2′), 3.44 (2H, *d*, *J* = 6.9 Hz, H-1′), 1.77, 1.60 (each 3H, 3′-Me's). EI-MS *m*/*z* (rel. int.): 328 [M$^+$] (62.6), 313 [M-Me]$^+$ (100), 273 (93.8), 272 (69.8), 260 (44.8), 244 (13.2).

4′, 5′-*Dihydro*-1,5,6-*trihydroxy*-4′,4′,5′-*trimethylfurano* (2′,3′:4,5) *xanthone* (**7**)

Pale yellow needles, mp 211–213°, IR, UV, ^{1}H NMR, ^{13}C NMR and EI-MS in good agreement with ref [19].

Kielcorin (**8**)

Pale yellow needles, mp 248–250°. IR, UV, ^{1}H NMR and EI-MS spectral data in good agreement with ref [31]. ^{13}C NMR (75 Hz, DMSO-d_6): *δ* 174.4 (C-9), 155.1 (C-4b), 147.9 (C-4′), 147.5 (C-2), 145.6 (C-3′), 141.0 (C-4a), 139.4 (C-3), 134.4 (C-6), 132.3 (C-4), 126.5 (C-1′), 125.6 (C-8), 123.9 (C-7), 120.6 (C-6′), 117.7 (C-5), 115.3 (C-5′), 113.7 (C-9a), 112.2 (C-2′), 105.8 (C-4), 96.5 (C-1), 77.6 (C-8′), 76.1 (C-7′), 59.7 (C-9′), 56.0, 55.6 (OMe's).

Cadensina (***9***)

Yellow needles, mp. 263–265°. IR, UV, ^{1}H NMR and EI-MS identical to refs [32, 33].

1,7-*Dihydroxyxanthone* (***10***)

Yellow needles, mp 236–238°. IR, UV, ^{1}H NMR and EI-MS in good agreement with ref [16].

1,7-*Dihydroxy*-4-*methoxyxanthone* (***11***)

Yellow needles, mp 238–240°. IR, UV, ^{1}H NMR and EI-MS spectral data in good agreement with ref [33].

1,2,5-*Trihydroxyxanthone* (***12***)

Yellow needles, mp 247–249°. IR, UV, ^{1}H NMR and EI-MS spectral data in good agreement with ref [34]. ^{13}C NMR (125 Hz, DMSO-d_6): δ 182.4 (C-9), 148.1 (C-1), 147.4 (C-4a), 146.2 (C-5), 145.5 (C-4b), 139.8 (C-2), 124.4 (C-7), 123.6 (C-3), 120.5 (C-6), 120.2 (C-8a), 114.5 (C-8), 108.4 (C-9a), 106.1 (C-4).

Acidic hydrolysis of ***1***

Compound 1 (2 mg) was dissolved in 5% HCl and heated at 100° for 3 hr, cooled and filtered. The filtrate was evaped to dryness. The residue was examined for sugar and aglycone by TLC on silica gel (*n*-BuOH-MeOH-H_2O) and polyamide ($CHCl_3$-MeOH).

Bioassay for coagulant activity

The plasma obtained from male Wistar rats was put into tubes ($n=5$), together with the compounds; normal saline was used as control. Then the reagents, APTT and PT (Active Partial Thromboplastin Time Reagent and Prothrombin Time Reagent, purchased from Pacific Homostasis, USA) were put into the above mentioned tubes and the clotting time was recorded at room temp. using the IR blood coagulation instrument (C-500, German).

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