Phytochemistry, Vol. 29, No. 11, pp. 3621–3625, 1990
Printed in Great Britain.

0031-9422/90 $3.00+0.00

HYDROLYSABLE TANNINS FROM *EUPHORBIA THYMIFOLIA*

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(*Received* 23 *February* 1990)

Key Word Index—*Euphorbia thymifolia*; Euphorbiaceae; hydrolysable tannins; gallotannins; ellagitannins; isomallotinic acid; valoneaic acid; hexahydroxydiphenic acid; dehydrohexahydroxydiphenic acid; gallic acid.

Abstract—Chemical investigation of *Euphorbia thymifolia* has led to the isolation and characterization of a new hydrolysable tannin named isomallotinic acid, in addition to 15 known tannins. The structure of isomallotinic acid was established on the basis of spectroscopic and chemical evidence.

INTRODUCTION

Euphorbia thymifolia (Euphorbiaceae) is a pantropical medicinal herb used as a diuretic and a laxative in Taiwan and to treat abdominal troubles and skin complaints in southeast Asia. The herb is astringent, but there has been no work on its active principles. As part of our studies on tannins in euphorbiaceous plants, we have investigated *E. thymifolia*, and isolated, together with 15 known tannins, 1-*O*-galloyl-3,6-(*R*)-valoneayl-*β*-D-glucose (**16**), which is an isomer of mallotinic acid (**17**) differing in the orientation of the valoneayl group in the glucose moiety. This paper deals with the isolation and characterization of these compounds.

RESULTS AND DISCUSSION

An aqueous acetone extract of the dried whole plants of *E. thymifolia* was subjected to a combination of Sephadex LH-20 and various reverse-phase (MCI-gel CHP 20P, Fuji-gel ODS G3, Bondapak C_{18}/Porasil B, cellulose, Prep-Pak 500/C_{18} and TSK-gel HW 40F) chromatographies to afford compounds **1**–**16**. Compounds **1**–**15** were identified as 2,3-di-*O*-galloyl-D-glucose (**1**) [2], 1,2,3-tri-*O*-galloyl-*β*-D-glucose (**2**) [unpublished data], 1,3,4,6-tetra-*O*-galloyl-*β*-D-glucose (**3**) [3], 1,2,3,4,6-penta-*O*-galloyl-*β*-D-glucose (**4**) [4], 2,3-(*S*)-4,4′,5,5′,6,6′-hexahydroxydiphenoyl (HHDP)-D-glucose (**5**) [5], 3-*O*-galloyl-4,6-(*S*)-HHDP-D-glucose (**6**) [6], pedunculagin (**7**) [7], 1-desgalloyleugeniin (**8**) [unpublished data], eugeniin (**9**) [8], rugosin B (**10**) [9], corilagin (**11**) [5], geraniin (**12**) [10], bixanin (**13**) [Tanaka, T. *et al.*, unpublished data], 5-desgalloylstachyurin (**14**) [11] and casuariin (**15**) [11] by comparisons of their spectroscopic and physical data with those of authentic samples.

The ^{1}H NMR spectrum of **16** shows a two-proton singlet (*δ*7.10) attributable to a galloyl group and three one-proton singlets (*δ*6.39, 6.84 and 7.12) in the aromatic field. The aliphatic resonances, whose chemical shifts and coupling patterns (see Experimental) were analogous to those of corilagin (**11**), suggesting the presence of a 1,3,6-acylated $^1C_4$-(or skew boat)-glucopyranose core.

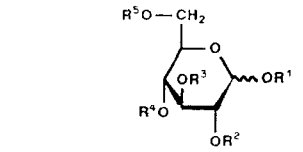
Methylation of **16** with $(Me)_2SO_4$ and K_2CO_3 in acetone afforded the dodecamethyl ether (**16a**). Subsequent alkaline hydrolysis of **16a**, followed by methylation with ethereal diazomethane, yielded methyl 3,4,5-trimethoxybenzoate (**16b**) and trimethyl octamethoxyvaloneate (**16c**) whose positive sign of specific optical rotation [+15.2° ($CHCl_3$)] confirmed the (*R*)-configuration of the biphenyl bond [12].

Hydrolysis of **16** with tannase yielded gallic acid and a partial hydrolysate (**16d**). On comparison of the ^{1}H NMR spectra of **16** and **16d**, the upfield shift of the anomeric signal in **16d** indicated that the location of the galloyl group in **16** is at the C-1 position.

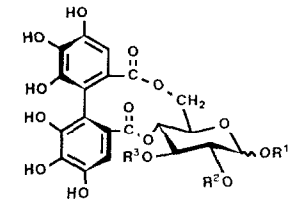
The configuration of the anomeric centre was determined to be *β* by observation of the similar H-1 coupling patterns in **16** and **11** and also from the chemical shift of the anomeric carbon signal (*δ*94.4). These findings suggested that **16** was 1-*O*-galloyl-3,6-(*R*)-valoneayl-*β*-D-glucose, consistent with the negative FAB mass spectral data (*m/z* 801 $[M-H]^-$). The ^{1}H NMR spectra of **16** and mallotinic acid (**17**) [12] differed in the chemical shifts of the valoneayl signals; **16** is thus considered to be a positional isomer of **17**.

The orientation of the valoneayl ester group was determined by ^{1}H–^{13}C long-range shift-correlation (COSY) spectroscopy. The correlations between the three one-proton aromatic singlets and the carboxyl carbon signals through three-bond couplings were clearly seen from the spectrum (Fig. 1). The signal at *δ*6.39 is correlated with the carbon signal at *δ*147.3, which is assignable to valoneayl C-4′ based on the lowfield shift caused by alkylation of the adjacent phenolic hydroxyl group. Thus, the signal at *δ*6.39 was concluded to correspond to H-3′. Because the singlet at *δ*7.12 was shown to be correlated with the signal at *δ*169.8, which is attributable to the carboxylic acid carbon from its broadness, this signal could be assigned to H-3″. The remaining aromatic signal at *δ*6.84 could therefore be assigned to H-3. Among three aromatic singlets, the H-3′ signal (*δ*6.89) was shown to be

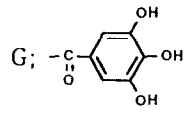
Part 99 in the series 'Tannins and Related Compounds'. For Part 98 see ref. [1].

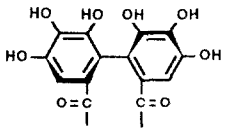


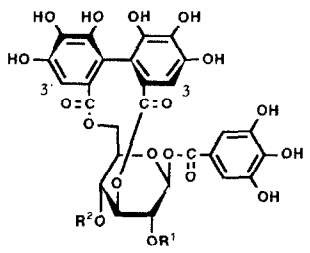
	R^1	R^2	R^3	R^4	R^5
1	OH	G	G	H	H
2	(β) G	G	G	H	H
3	(β) G	H	G	G	G
4	(β) G	G	G	G	G
5	OH	(S)HHDP		H	H



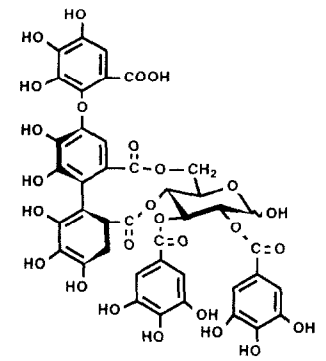
	R^1	R^2	R^3
6	OH	H	G
7	OH	(S) HHDP	
8	H	G	G
9	(β) G	G	G

G; 

(S)HHDP 



11 $R^1 = R^2 = H$



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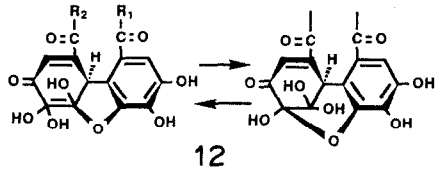

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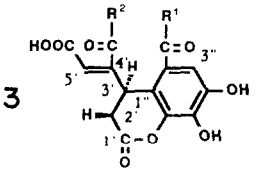

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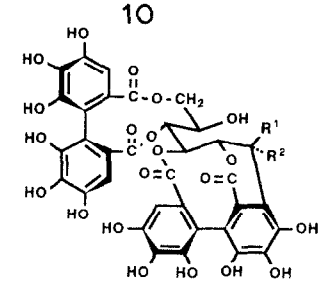


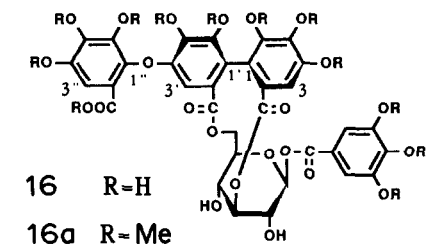
14 R^1=OH, R^2=H

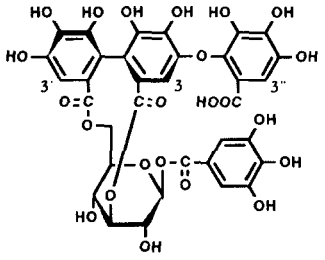
15 R^1=H, R^2=OH

coupled with the carboxyl carbon signal at δ168.7 and also with the glucose H-6 singlet at δ4.80. These facts clearly indicated the orientation of the valoneayl group to be as shown by the formula **16**.

A hydrolysable tannin (euphorbin B) having the same orientation of the valoneayl group as that of isomallotinic acid was previously isolated from *E. hirta* [13], this is the second isolation of a similar type. It is interesting from the chemotaxonomic point of view that mallotinic acid (**17**) and related hydrolysable tannins (e.g. mallotusinic acid, mallojaponin, mallotunin, etc.) have so far been reported to occur in the plants of the genera *Mallotus* [12, 14, 15] *Macaranga* [16] and *Excoecaria* [1], all belonging to Euphorbiaceae, whereas the distribution of isomallotinic acid-type is limited to the genus *Euphorbia*.

Differentiation of the isomallotinic acid-type from the alternatives is possible by ^{1}H NMR examination (Table 1). That is, among three aromatic singlets arising from the





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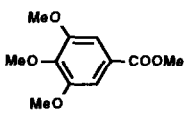
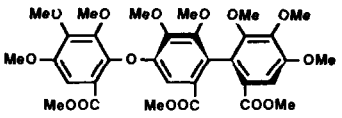
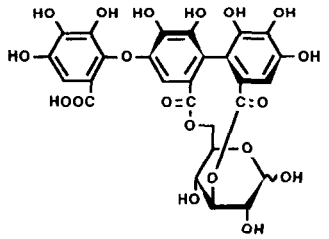


16b



16c



16d

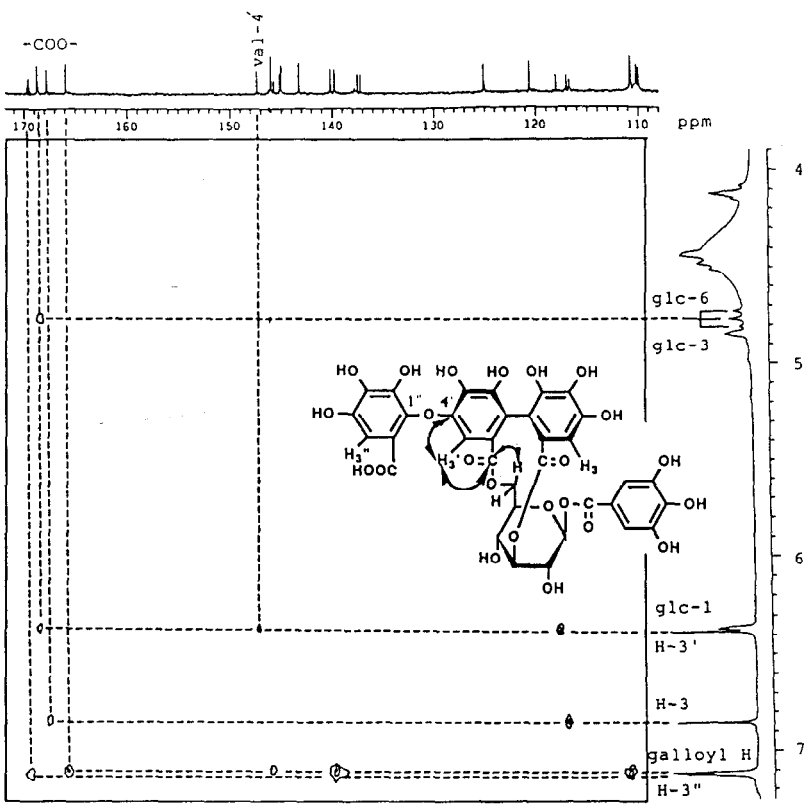


Fig. 1. ^{1}H–^{13}C Long-range COSY spectrum (J_{CH} = 10 Hz) of **16** (270 MHz, Me_2CO-d_6 + D_2O).

valoneayl group, and 'branched' gallic acid signal appears almost constantly in the region of δ7.1–7.2, the chemical shift being almost the same as that of gallic acid. On comparison of the two upper field singlets with those of corilagin (**11**), the signal arising from the aromatic ring located at the glucose C-6 position was shifted to the upper field by *ca* δ0.3 in the isomallotionic acid-type. On the other hand, in the case of the mallotinic acid-type, the signal of the aromatic proton at the glucose C-3 was observed at the higher field by δca 0.2–0.3, whereas the chemical shift of the alternative signal was almost the same as that of **11**. These chemical shift changes may be

Table 1. Chemical shifts of valoneayl signals (270 MHz)

	Chemical shifts (δ)		
	H-3	H-3′	H-3″*
Corilagin (**11**) [5]†	6.84	6.69	
Isomallotinic acid (**16**)‡	6.84	6.39	7.12
Euphorbin B [13]†	6.84	6.40	7.13
Mallotinic acid (**17**) [12]†	6.51	6.72	7.13
Repandusinin [14]†	6.56	6.67	7.20
Mallotannin A [15]‡	6.51	6.72	7.16
Mallotannin B [15]‡	6.53	6.73	7.12

*H-3, H-3′ and H-3″: Aromatic ring protons located at the glucose C-3 and C-6 positions and at the branched gallic acid moiety, respectively.

†In acetone-d_6.

‡In acetone-d_6 + D_2O.

attributable to anistropic and inductive effects caused by substitution of the hydroxyl group with the 'additional galloyl residue'.

EXPERIMENTAL

General. Mps: uncorr. FABMS were measured at 2 kV with DMSO-glycerol as matrix. NMR spectra were recorded at 270 and 100 MHz (for ^1H) and 25.05 MHz (for ^{13}C), chemical shifts are given in δ (ppm) scale with TMS as int. standard. CC was carried out on Sephadex LH-20, Bondapak C_{18}/Porasil B, MCI-gel CHP 20P, Fuji-gel ODS G3, Prep-pak 500/C_{18}, Kieselgel 60, Avicel cellulose and TSK-gel HW 40F. TLC was conducted on precoated silica gel 60 F_{254} plates and precoated cellulose F_{254} plates. Spots were visualized under UV and by spraying $FeCl_3$ (for phenolics) and 10% H_2SO_4, followed by heating (for phenolics and sugars).

Plant material. Whole plants of *E. thymifolia* L. were collected in Taiwan. A voucher specimen is deposited at the Herbarium, Faculty of Pharmaceutical Sciences, Kyushu University.

Isolation of tannins. Dried whole plants (2.5 kg) were chopped into small pieces and extractd × 4 with 80% aq. Me_2CO at room temp. The Me_2CO was removed *in vacuo* and the insolubles filtered off. The filtrate was concd and subjected to Sephadex LH-20 CC. Elution with H_2O containing increasing proportions of MeOH afforded 4 frs; I (3 g), II (19 g), III (10 g) and IV (12 g). Fr. I was CC over MCI-gel CHP-20P, Fuji-gel ODS G3 and Bondapak C_{18}/Porasil B with a H_2O–MeOH gradient system to give 1,3,4,6-tetra-*O*-galloyl-β-D-glucose (**3**) (27 mg) and 1,2,3,4,6-penta-*O*-galloyl-β-D-glucose (**4**) (40 mg). Fr. II was repeatedly CC over MCI-gel CHP-20P, Fuji-gel ODS G3, TSK-gel HW-40F, Prep-pak 500/C_{18} and Bondapak C_{18}/Porasil B with an H_2O–MeOH gradient system to give 2,3-di-*O*-galloyl-D-glucose (**1**) (70 mg), 1,2,3-tri-*O*-galloyl-β-D-glucose (**2**) (48 mg), 2,3-(*S*)-HHDP-D-glucose (**5**) (16 mg) and 3-*O*-galloyl-4,6-(*S*)-HHDP-D-glucose (**6**) (48 mg). Sepn of fr. III by repeated CC on Sephadex LH-20 with EtOH, cellulose with 2% HOAc and MCI-gel CHP 20P and Fuji-gel ODS G3 with H_2O-MeOH (1:0–2:3) yielded pedunculagin (**7**) (480 mg), 1-desgalloyleugeniin (**8**) (54 mg) and eugeniin (**9**) (15 mg). On similar CC, fr. IV gave rugosin B (**10**) (170 mg), corilagin (**11**) (226 mg), geraniin (**12**) (2.4 g), bixanin (**13**) (28 mg), 5-desgalloylstachyurin (**14**) (30 mg), casuariin (**15**) (120 mg) and isomallotinic acid (**16**) (190 mg).

2,3-*Di*-O-*galloyl*-D-*glucose* (**1**). Off-white amorphous powder, $[\alpha]_D$ + 133° (Me_2CO; *c* 0.5). ^1H NMR (Me_2CO-d_6 + D_2O): δ4.96 (*dd*, *J* = 4 and 8 Hz, α-2), 5.10 (*t*, *J* = 8 Hz, β-2), 5.40 (*t*, *J* = 8 Hz, β-3), 5.41 (*d*, *J* = 8 Hz, β-1), 5.48 (*d*, *J* = 4 Hz, α-1), 5.76 (*t*, *J* = 9 Hz, α-3), 7.05, 7.07, 7.11 (each *s*, galloyl H).

1,2,3-*Tri*-O-*galloyl*-β-D-*glucose* (**2**). Pale brown amorphous powder, $[\alpha]_D$ + 28.6° (Me_2CO; *c* 0.7). ^1H NMR (Me_2CO-d_6 + D_2O): δ5.46 (1H, *t*, *J* = 8 Hz, Glc-2), 5.65 (1H, *t*, *J* = 8 Hz, Glc-3), 6.09 (1H, *d*, *J* = 8 Hz, Glc-1), 7.01, 7.08, 7.10 (each 2H, *s*, galloyl H).

1,3,4,6-*Tetra*-O-*galloyl*-β-D-*glucose* (**3**). Pale brown amorphous powder, $[\alpha]_D$ + 38.2° (Me_2CO; *c* 0.6). ^1H NMR (Me_2CO-d_6 + D_2O): δ4.07 (1H, *dd*, *J* = 8 and 9 Hz, Glc-2), 5.49 (1H, *t*, *J* = 9 Hz, Glc-4) 5.70 (1H, *t*, *J* = 9 Hz, Glc-3), 6.01 (1H, *d*, *J* = 8 Hz, Glc-1), 7.07, 7.10, 7.15, 7.21 (each 2H, *s*, galloyl H).

1,2,3,4,6-*Penta*-O-*galloyl*-β-D-*glucose* (**4**). Pale brown amorphous powder, $[\alpha]_D$ + 18.0° (Me_2CO; *c* 0.6). ^1H NMR (Me_2CO-d_6): δ5.66 (1H, *t*, *J* = 8 Hz, Glc-3), 5.69 (1H, *t*, *J* = 8 Hz, Glc-4), 6.05 (1H, *t*, *J* = 8 Hz, Glc-3), 6.32 (1H, *d*, *J* = 8 Hz, Glc-1), 7.00, 7.03, 7.08, 7.10, 7.16 (each 2H, *s*, galloyl H).

2,3-S-*HHDP*-D-*glucose* (**5**). Pale brown amorphous powder, $[\alpha]_D$ + 45.3° (H_2O; *c* 1.0). ^1H NMR (Me_2CO-d_6): δ4.76 (*d*, *J* = 8 Hz, β-1), 4.93 (*dd*, *J* = 3 and 8 Hz, α-2), 5.03 (*t*, *J* = 9 Hz, β-3), 5.37 (*t*, *J* = 8 Hz, α-3), 5.39 (*d*, *J* = 3 Hz, α-1), 6.62, 6.63, 6.70, 6.71 (each *s*, HHDP-H).

3-O-*Galloyl*-4,6-(S)-*HHDP*-D-*glucose* (**6**). Pale brown amorphous powder, $[\alpha]_D$ + 40.6° (Me_2CO; *c* 0.7). ^1H NMR (Me_2CO-d_6 + D_2O): δ6.46, 6.64 (each *s*, HHDP-H), 7.04 (2H, *s*, galloyl H).

Pedunculagin (**7**). Pale brown amorphous powder, $[\alpha]_D$ + 86.0° (Me_2CO; *c* 1.4. ^1H NMR (Me_2CO-d_6): δ3.60–5.70 (7H in total, *m*, Glc-H), 6.35, 6.52, 6.56, 6.61, 6.67 (4H in total, each *s*, HHDP-H).

1-*Desgalloyleugeniin* (**8**). Pale brown amorphous powder, $[\alpha]_D$ + 100.8° (Me_2CO; *c* 1.3). ^1H NMR (Me_2CO-d_6): δ3.80, 3.87 (each *d*, *J* = 13 Hz, Glc-6), 5.14 (*d*, *J* = 8 Hz, β-1), 5.57 (*d*, *J* = 4 Hz, α-1), 5.60 (*t*, *J* = 9 Hz, β-3), 5.89 (*d*, *J* = 10 Hz, α-3), 6.51, 6.52, 6.67 (2H in total, each *s*, HHDP-H), 6.97, 7.02, 7.08, 7.09 (4H in total, each *s*, galloyl H).

Eugeniin (**9**). Pale brown amorphous powder, $[\alpha]_D$ + 62.2° (Me_2CO; *c* 0.8). ^1H NMR (Me_2CO-d_6): δ3.89 (1H, *d*, *J* = 13 Hz, Glc-6), 4.53 (1H, *dd*, *J* = 6 and 9 Hz, Glc-5), 5.24 (1H, *t*, *J* = 9 Hz, Glc-4), 5.39 (1H, *dd*, *J* = 6 and 13 Hz, Glc-6), 5.62 (1H, *t*, *J* = 9 Hz, Glc-2), 5.86 (1H, *t*, *J* = 9 Hz, Glc-3), 6.22 (1H, *d*, *J* = 9 Hz, Glc-1). 6.50, 6.67 (each 1H, *s*, HHDP-H), 6.98, 7.01, 7.12 (each 2H, *s*, galloyl H).

Rugosin B (**10**). Pale brown amorphous powder, $[\alpha]_D$ + 124.0° (EtOH; *c* 1.0). ^1H NMR (Me_2CO-d_6 + D_2O): δ3.68 (*dd*, *J* = 1 and 13 Hz, α-6), 3.76 (*dd*, *J* = 1 and 13 Hz, β-6), 4.23 (*ddd*, *J* = 1, 7 and 10 Hz, β-5), 4.63 (*ddd*, *J* = 1, 7 and 10 Hz, α-5), 5.06 (*t*, *J* = 10 Hz, α, β-4), 5.10 (*d*, *J* = 8 Hz, β-1), 5.12 (*dd*, *J* = 4 and 10 Hz, α-2), 5.21 (*dd*, *J* = 7 and 13 Hz, β-6), 5.23 (*dd*, *J* = 7 and 13 Hz, β-6), 5.24 (*dd*, *J* = 8 and 10 Hz, β-2), 5.52 (*d*, *J* = 4 Hz, α-1), 5.60 (*t*, *J* = 10 Hz, β-3), 5.86 (*t*, *J* = 10 Hz, α-3), 6.31, 6.32, 6.46, 6.48 (3H in total, each *s*, valoneayl H), 6.96, 7.00, 7.06, 7.07 (4H in total, each *s*, galloyl H).

Corilagin (**11**). White powder (H_2O), mp 211–212°, $[\alpha]_D$ −203.1° (Me_2CO; *c* 0.9). ^1H NMR (Me_2CO-d_6): δ4.01–4.20 (2H in total, *m*, Glc-2 and 6), 4.43–4.64 (2H in total *m*, Glc-4 and 5), 4.83–5.08 (2H, *m*, Glc-3 and 6), 6.38 (1H, *br s*, Glc-1), 6.69, 6.84 (each 1H, *s*, HHDP-H), 7.12 (2H, *s*, galloyl H).

Geraniin (**12**). Yellow powder (H_2O), $[\alpha]_D$ −147.8° (MeOH; *c* 0.9), mp 218–221° (decomp.). ^1H NMR (Me_2CO-d_6): δ4.28–4.54 (1H, *m*, Glc-5), 4.68–5.00 (2H in total, Glc-3 and 6), 5.17 (1H, *s*, benzylmethine H), 5.40–5.60 (3H in total, Glc-2, 4 and 6), 6.59 (1H, *s*, Glc-1), 6.67, 7.11 (each 1H, *s*, HHDP-H), 7.19 (2H, *s*, galloyl-H), 7.28 (1H, *s*, aromatic H).

Bixanin (**13**). Off-white amorphous powder, $[\alpha]_D$ −63.9°

(MeOH; *c* 0.8). ^{1}H NMR (Me_2CO-d_6 + D_2O): δ4.80–4.89 (2H in total, *m*, Glc-5 and 6), 5.19 (1H, *d*, *J* = 6 Hz, H-2′), 5.35 (1H, *br s*, Glc-2), 5.38 (1H, *br s*, Glc-4), 5.40 (1H, *d*, *J* = 6 Hz, H-3′), 5.52 (1H, *d*, *J* = 4 Hz, Glc-3), 6.42 (1H, *s*, H-5′), 6.80 (1H, *br s*, Glc-1), 6.66, 6.89 (each 1H, HHDP-H), 7.11 (1H, *s*, aromatic H), 7.21 (2H, *s*, galloyl H).

5-Desgalloylstachyurin (**14**). Pale brown amorphous powder, $[\alpha]_D$ −26.5° (MeOH; *c* 0.8). ^{1}H NMR (Me_2CO-d_6 + D_2O): δ4.80 (1H, *dd*, *J* = 3 and 10 Hz, Glc-1), 4.91–5.00 (4H in total, *m*, Glc-2, 3, 5 and 6), 5.27 (1H, *dd*, *J* = 2 and 9 Hz, Glc-4), 6.47, 6.58, 6.85 (each 1H, *s*, aromatic H).

Casuariin (**15**). Pale brown amorphous powder, $[\alpha]_D$ + 129.3° (MeOH; *c* 1.0). ^{1}H NMR (Me_2CO-d_6 + D_2O): δ3.88 (1H, *d*, *J* = 12 Hz, Glc-6), 4.14 (1H, *dd*, *J* = 2 and 8 Hz, Glc-5), 4.71 (1H, *dd*, *J* = 2 and 12 Hz, Glc-6), 4.80 (1H, *dd*, *J* = 3 and 5 Hz, Glc-2), 5.11 (1H, *dd*, *J* = 3 and 8 Hz, Glc-4), 5.51 (1H, *t*, *J* = 3 Hz, Glc-3), 5.62 (1H, *d*, *J* = 5 Hz, Glc-1), 6.45, 6.57, 6.79 (each 1H, *s*, aromatic H).

Isomallotinic acid (**16**). Pale brown amorphous powder, $[\alpha]_D$ −37.5° (Me_2CO; *c* 0.3). Anal. Calcd for $C_{34}H_{26}O_{23} \cdot 3/2H_2O$: C, 49.20; H, 3.49. Found: C, 49.15; H, 3.27. Negative FABMS *m/z* 801 $[M-H]^-$. ^{1}H NMR (Me_2CO-d_6 + D_2O): δ4.06 (1H, *dd*, *J* = 8 and 11 Hz, Glc-6), 4.07 (1H, *br s*, Glc-2), 4.40 (1H, *d*, *J* = 3 Hz, Glc-4), 4.47 (1H, *t*, *J* = 8 Hz, Glc-5), 4.80 (1H, *t*, *J* = 11 Hz, Glc-6), 4.81 (1H, *d*, *J* = 3 Hz, Glc-3), 6.35 (1H, *d*, *J* = 2 Hz, Glc-1), 6.39, 6.84, 7.12 (each 1H, *s*, valoneayl H), 7.10 (2H, *s*, galloyl-H). ^{13}C NMR (Me_2CO-d_6 + D_2O): δ64.3 (Glc-4), 68.7 (Glc-6), 70.9 (Glc-2), 72.5 (Glc-3), 75.3 (Glc-5), 94.4 (Glc-1), 106.3 [valoneayl (Val)-3″], 109.6, 110.0 (Val-3 and 3′), 110.6 (galloyl-2 and 6), 116.8 (Val-1), 117.9 (Val-1′), 120.2 (galloyl-1), 124.7 (Val-2 and 2′), 136.8 (Val-5), 137.4 (Val-5′), 139.0 (galloyl-4), 140.0 (Val-4″), 142.9 (Val-1″), 144.9 (Val-6 and 6′), 145.8 (galloyl-3 and 5), 147.3 (Val-4′), 165.9, 167.8, 168.7 and 169.8 (–CO_2–).

Methylation of **16**. A mixt. of **16** (70 mg), $(Me)_2SO_4$ (1 ml) and dry K_2CO_3 (1 g) in dry Me_2CO (10 ml) was heated under reflux for 3 hr. After removal of inorganic salts by filtration, the filtrate was concd to a syrup and subjected to silica gel CC. Elution with C_6H_6–Me_2CO (9:1) gave the dodecamethyl ether (**16a**) (48 mg) as an off-white amorphous powder, $[\alpha]_D$ −52.1° ($CHCl_3$; *c* 0.3). Positive FABMS *m/z* 970 $[M+H]^+$. ^{1}H NMR ($CDCl_3$): δ2.17 (3H, *s*, CO_2Me), 3.68–4.10 (33H in total, each *s*, OMe), 4.86–5.00 (2H in total, *m*, Glc-3 and 6), 6.38, 6.48, 7.36 (each 1H, *s*, aromatic H), 6.56 (1H, *d*, *J* = 3 Hz, Glc-1), 7.18 (2H, *s*, galloyl-H).

Alkaline hydrolysis of **16a**, *followed by* CH_2N_2 *methylation*. A soln of **16a** (30 mg) in 5% aq. NaOH (2 ml) was heated at 90° for 1 hr. The mixt. was acidified with 2 M HCl and extracted with Et_2O. The Et_2O layer was washed with H_2O, dried (Na_2SO_4) and concd to dryness. The residue was treated with CH_2N_2–Et_2O for 1 hr, concd to dryness and subjected to silica gel CC. Elution with C_6H_6–Me_2CO (12:1) gave methyl 3,4,5-trimethoxybenzoate (**16b**) (4 mg), mp 81°, and trimethyl (*R*)-octamethoxyvaloneate (**16c**) (6.5 mg) as a white amorphous powder, $[\alpha]_D$ + 15.2° ($CHCl_3$; *c* 0.6).

Partial hydrolysis of **16** *with tannase*. A soln of **16** (20 mg) in H_2O (2 ml) was shaken with tannase at room temp. for 1 hr. The mixt. was applied to a Sephadex LH-20 column and eluted with 30% MeOH to give gallic acid (2 mg) and a hydrolysate (**16d**) (5 mg) as a pale brown amorphous powder, $[\alpha]_D$ + 32.0° (Me_2CO; *c* 0.5). ^{1}H NMR (Me_2CO-d_6 + D_2O): δ3.60–4.50 (7H in total, Glc-H), 6.41, 6.46, 6.70, 6.74, 7.13, 7.15 (3H in total, each *s*, valoneayl H).

Acknowledgements—The authors are indebted to Mr Y. Tanaka, Miss Y. Soeda and Mr K. Isobe for NMR and MS measurements and to the staff of the Central Analysis Room of this University for elemental analysis.

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