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SECOMULTIFLORANE-TYPE TRITERPENOID ACIDS FROM STEM BARK OF *SANDORICUM KOETJAPE*

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Key Word Index—*Sandoricum koetjape*; Meliaceae; stem bark; bryononic acid; secobryononic acid; secoisobryononic acid.

Abstract—Bryononic acid and two new ring-A secotriterpenoids were isolated from *Sandoricum koetjape* stem bark and their structures elucidated by NMR spectrometry.

INTRODUCTION

The stem bark of *Sandoricum koetjape* was collected in Jakarta, Indonesia. Local people use this plant against colic and leucorrhoea [1]. In previous investigations bryononic acid, bryonolic acid, mesoinositol and dimethyl mucate were isolated from the fruit hulls [2], two triterpenoid acids, katonic acid and indicic acid, were isolated from the heartwood [3], while limonoids were isolated from the seeds [4]. The stem bark has been investigated and koetjape acid, 3-oxo-olean-12-en-29-oic acid, katonic acid, (−)-alloaromadendrene, (−)-caryophyllene oxide, and (+)-spathulenol [5] were isolated. Further fractionation of the petrol extract of stem bark of *S. koetjape* planted in Indonesia resulted in the isolation of two new secomultiflorane-type triterpenoids, named secobryononic acid (**2**) and secoisobryononic acid (**3**), along with bryononic acid (**1**), and we report here their structure elucidation.

RESULTS AND DISCUSSION

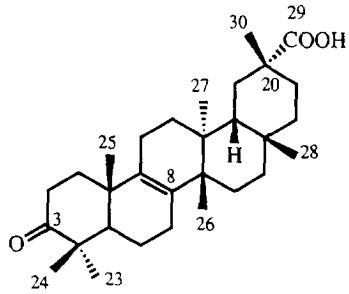
Dried powdered stem bark of *S. koetjape* was extracted with petrol for a week. After removal of the solvent the crude extract was separated using column chromatography to yield **1** and a mixture of compounds **2** and **3** which were separated and purified further as the methyl esters (**4** and **5**) using HPLC.

The molecular formula of **1** was determined as $C_{30}H_{46}O_3$ from its HR-mass spectrum indicating that it was a triterpenoid. The presence of two carbonyl groups was inferred by a combination of the IR (ν_{max} 1726 and 1676 cm^{-1}) and the ^{13}C NMR (δ218.2 and 185.5) (Table 1) spectra. Seven methyl groups were indicated by both the ^{13}C NMR [δ18.1, 19.4, 21.1, 21.6, 26.8, 31.2 and 32.7) and the ^1H NMR [δ0.84 (3H), 0.96 (3H), 1.03 (6H), 1.06 (3H), 1.09 (3H) and 1.22 (3H)] spectra. The ^1H NMR, IR and mass spectra were identical with those of bryononic acid isolated from fruit hulls of the same plant [2]. Since we are interested in the conformation of this kind of triterpene, a crystal of **1** was analysed by X-ray spectrometry. The result is shown in Fig. 1. The A and E rings have chair conformations.

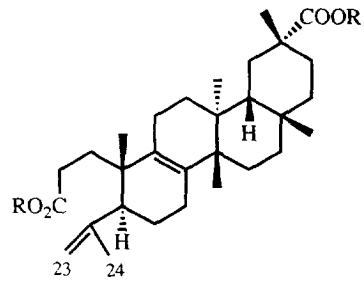
Compound **4** had the molecular formula $C_{32}H_{50}O_4$ as determined by HR-mass spectrometry. The presence of two ester carbonyl groups was inferred from the ^{13}C NMR (δ179.2 and 174.7) spectrum (Table 1). Six methyl and two methoxyl groups were shown by the ^{13}C NMR (δ18.1, 21.6, 23.1, 23.3, 30.9, 31.3, 51.4 and 51.5) and the ^1H NMR [δ0.79 (3H), 0.93 (3H), 0.96 (3H), 1.04 (3H), 1.18 (3H), 1.75 (3H), 3.62 (3H) and 3.63 (3H)] spectra. An exomethylene group (δ4.66 and 4.89) and a tetrasubstituted double bond were also present. Compound **4** was thus tetracyclic. The HMBC spectrum indicated the correlations of the six methyl groups as shown in Fig. 2. Thus compound **4** was revealed to be 3,4-secobryononic acid dimethyl ester. The stereochemistry is assumed to be the same as in **1**.

The HR-mass spectrum of **5** showed 498.3705 indicating the molecular formula $C_{32}H_{50}O_4$. The presence of two ester carbonyl groups was indicated by the ^{13}C NMR (δ174.8 and 179.4) spectrum (Table 1).

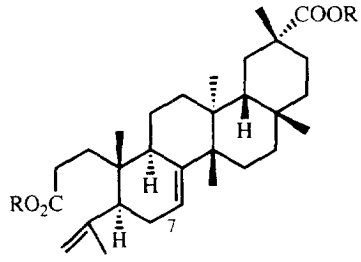
Six methyl and two methoxyl groups were observed in the ^{13}C NMR spectrum (δ15.9, 22.5, 23.9, 24.8, 31.2, 32.9, 51.6 and 51.7). The data were supported by the presence of six singlet methyl and two singlet methoxyl groups in the ^1H NMR spectrum [δ0.82 (3H), 0.86 (3H), 0.97 (3H), 1.01 (3H), 1.19 (3H), 1.78 (3H), 3.64 (3H) and 3.68 (3H)]. The exomethylene group at C-23 had similar shifts in the ^1H and ^{13}C NMR spectra (δ4.78, 4.83 and 113.8) to those of **4**. A trisubstituted double bond was present as indicated by the ^1H NMR [δ5.44 (1H, *t*, J=2 Hz)] and ^{13}C NMR [(δ117.2 (*t*) and 145.7 (*s*)] spectra. Thus **5** was also tetracyclic. From the HMBC spectrum, compound **5**



Bryononic acid (**1**)



Secobryononic acid (**2**) R=H
4 R=Me



Secoisobryononic acid (**3**) R=H
5 R=Me

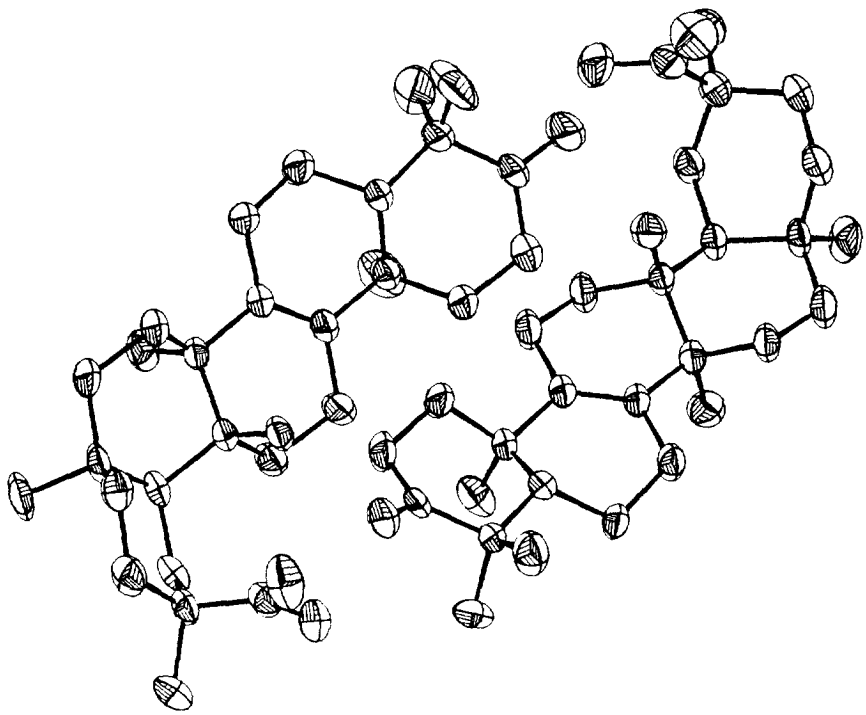


Fig. 1. The ORTEP drawing for bryononic acid (**1**).

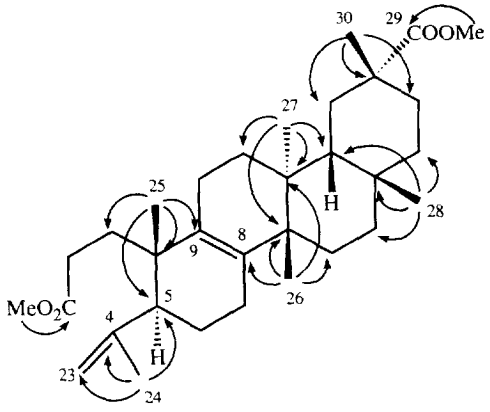


Fig. 2. The HMBC correlations for compound **4**.

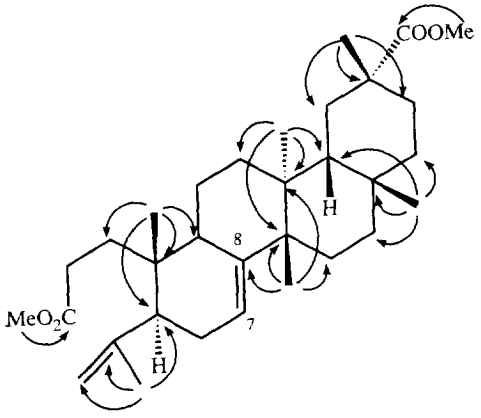


Fig. 3. The HMBC correlations for compound **5**.

was revealed to be 3,4-secooleana-4(23),7-diene-3,29-dioic acid dimethyl ester as shown in Fig. 3.

Table 1. ^{13}C NMR (100 MHz) data for compounds **1**, **4** and **5** ($CDCl_3$)

C	1	4	5
1	34.2[a]	31.6	31.7
2	35.4[a]	29.7	28.1
3	218.2	174.7	174.8
4	47.1	147.4	147.5
5	51.1	46.4	49.0
6	20.5[b]	25.1[a]	30.3[a]
7	27.7[b]	26.5[a]	117.2
8	134.9	138.9	145.7
9	132.7	129.5	40.3
10	30.8	41.2	37.1
11	20.6[b]	20.9	17.5[a]
12	29.9	30.3	35.7
13	42.2	37.1[b]	36.0
14	37.0	47.8[b]	42.5
15	25.2	24.8	29.2
16	34.4[a]	34.4	32.9
17	37.4	30.9	31.2
18	44.4	44.6	47.3
19	30.4	30.0[c]	30.7
20	40.4	40.4	40.4
21	29.5	30.7[c]	29.6
22	36.8[a]	36.9	36.9
23	21.1	113.8	113.8
24	26.8	23.1	22.5
25	19.4	23.3	15.9
26	21.6	21.6	23.9
27	18.1	18.1	24.8
28	31.2	31.3	31.4
29	185.5	179.2	179.4
30	32.7	32.7	33.2
OMe		51.4	51.4
OMe		51.5	51.4

[a–c]Assignments may be changed within each vertical column.

EXPERIMENTAL

Mps: uncorr. Spectral data: NMR, 100 MHz for ^{13}C and 400 MHz for ^{1}H; TMS, $CDCl_3$.

Plant material. Sandoricum koetjape was collected in Jakarta, Indonesia in 1993. The voucher specimen is deposited at Bogor Herbarium and identified by M.S. Nani.

Extraction and isolation. The dried powdered stem bark of *S. koetjape* (1.05 kg) was extracted with 5 l petrol at room temp. After removal of the solvent under red. pres. a residue (36.4 g) was obtained. The residue (18.1 g) was subjected to CC on silica gel (160 g) with petrol and petrol–EtOAc as eluents. Frs 6–9 were combined, kept overnight and yielded **1** (1.5 g) as crystals. Frs 15–17 were a mixture of **2** and **3** (240 mg). The mixture was methylated with CH_2N_2 and sepd using HPLC to give the dimethyl esters **4** (16.5 mg) and **5** (9.2 mg).

Bryononic acid (**1**). 250–253°, prism; IR ν_{max} cm^{-1}: 1726, 1676, 1458, 1382; ^{1}H NMR: δ0.84 (3H, *s*), 0.96 (3H, *s*), 1.03 (6H, *s*), 1.06 (3H, *s*), 1.09 (3H, *s*) and 1.22 (3H, *s*); ^{13}C NMR (Table 1); EI-MS *m/z* (rel. int.): 454 $[M]^+$ (51), 439 (29), 410 (13), 395 (10), 271 (7), and Int. 257 (76), 245 (73), 235 (100), 189 (25), 133 (15), 123 (7), 121 (19), 109 (16), 95 (26), 81 (11); HR-MS *m/z*: 454.3458 $[M]^+$ (calcd. for $C_{30}H_{46}O_3$, 454.3435).

Secobryononic acid methyl ester (**4**) (*dimethyl* 3,4-*secomultiflora*-4(23),8-*diene*-3,29-*dioate*. $[\alpha]_D^{22}$ + 18.2°, ($CHCl_3$; *c* 1.65); IR ν_{max} cm^{-1}: 1730, 890; ^{1}H NMR: δ0.79 (3H, *s*, H-27), 0.93 (3H, *s*, H-25), 0.96 (3H, *s*, H-26), 1.04 (3H, *s*, H-28), 1.18 (3H, *s*, H-30), 1.75 (3H, *s*, H-24), 3.62 (3H, *s*, OMe-29), 3.63 (3H, *s*, OMe-3), 4.66 (1H, *s*, H-23), 4.89 (1H, *s*, H-23); ^{13}C NMR (Table 1); EI-MS *m/z* (rel. int.): 498 $[M]^+$ (90), 483 (10), 411 (100), 275 (20), 249 (50), 235 (15), 189 (45), 161 (40), 147 (20); HR-MS *m/z*: 498.3690 $[M]^+$ (calcd. for $C_{32}H_{50}O_4$, 498.3698).

Secoisobryononic acid methyl ester (**5**) (*dimethyl* 3,4-*secomultiflora*-4(23),7-*diene*-3,29-*dioate*). $[\alpha]_D^{22}$ −23.2°, ($CHCl_3$; *c* 0,92); IR ν_{max} cm^{-1}: 1730, 890; ^{1}H NMR: δ0.82 (3H, *s*, H-25), 0.86 (3H, *s* H-27), 0.97 (3H, *s*, H-26), 1.01 (3H, *s*, H-28), 1.19 (3H, *s*, H-30), 1.78 (3H, *s*, H-24), 3.64 (3H, *s*, OMe-29), 3.68 (3H, *s*, OMe-3), 4.78 (1H, *s*, H-23),

4.83 (1H, *s*, H-23), 5.44 (1H, *t*, $J=2$ Hz, H-7); ^{13}C NMR (Table 1); EI-MS *m/z* (rel. int.): 498 $[M]^+$ (100), 483 (13), 411 (72), 275 (18), 249 (43), 235 (10), 189 (48), 161 (27), 147 (20); HR-MS *m/z*; 498.3705 $[M]^+$ (calcd. for $C_{32}H_{50}O_4$, 498.3696).

Single-crystal X-ray diffraction analysis of bryononic acid (**1**). The crystals were prepared from $CHCl_3$–MeOH. The crystal data for **1** were as follows: triclinic; space group P1 with $a = 6.678\,(1)$, $b = 13.756\,(3)$, $c = 14.625\,(2)$ Å, $\alpha = 100.48\,(2)$, $\beta = 98.72\,(2)$, $\gamma = 92.42\,(2)^\circ$, $V = 102.4\,(4)$ Å^3, and $Z=2$. The empirical formula was $C_{30}H_{46}O_3$, $M_r = 454$, and calculated density was 1.16 g cm^{-3}. 3D X-ray data were collected using a graphite-monochromated CuK_α radiation ($\lambda = 1.54178$) on a Mac Science MXC18 automatic four-circle diffractometer. Of 4267 total unique reflections, 4225 were used. The structure was solved by a direct method (Shelxs). The crystal has two molecules in a unit cell. The final *R* factor was $R = 0.050$, $Rw = 0.067$. Atomic coordinates, bond lengths and angles, and thermal parameters have been deposited at the Cambridge Crystallographic Data Centre.

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