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TWO NEW FLAVONE GLYCOSIDES FROM *CIRSIUM LINEARE**

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Key Word Index—*Cirsium lineare*; Compositae; flavone glycosides; cirsilineol 4′-glucoside and cirsiliol 4′-glucoside.

Abstract—An examination of four species of *Cirsium* disclosed the presence of two new flavonoids in *C. lineare*. The structure of one was 5,4′-dihydroxy-6,7,3′-trimethoxyflavone (cirsilineol) 4′-monoglucoside and the other 5,3′,4′-trihydroxy-6,7-dimethoxyflavone (cirsiliol) 4′-monoglucoside. Luteolin 7-glucoside was found in *C. suffultum*, and pectolinarin and linarin in *C. kamtschaticum* and *C. pectinellum*.

INTRODUCTION

WHILE investigating the distribution of flavonoids in Japanese *Cirsium* species, seven major flavonoids have already been reported from 23 species[1–5] (Table 1). In this report, two new groups of species were examined, one of which was found to have two new flavonoids, cirsilineol 4′-glucoside and cirsiliol 4′-glucoside, and the other group, pectolinarin and linarin.

TABLE 1. DISTRIBUTION OF FLAVONOIDS IN CIRSIUM

Flavonoids	*Cirsium* spp.	Flavonoids	*Cirsium* spp.
Pectolinarin (Group 1)	*C. microspicatum*, *C. babanum* var. *otayae*, *C. japonicum*, *C. kagamontanum*, *C. inundatum*, *C. microspicatum* var. *kiotoense*, *C. dipsacolepis*, *C. brevicaule*, *C. yezoense*	Cirsimarin (Group 5)	*C. maritimum*, *C. tanakae* ssp. *aomorense*
		Rhoifolin (Group 6)	*C. bitchuense*
Luteolin 7-glucoside (Group 2)	*C. matsumurae*, *C. matsumurae var. pubescens*, *C. yakusimense*, *C. amplexifolium*, *C. buergeri*, *C. nipponicum* var. *yoshinoi*, *C. gyojanum*, *C. lucens*, *C. suffultum**	Rutin (Group 7)	*C. arvense* var. *setosum* (*Cephalonoplos setosum*)†
		Pectolinarin and linarin (Group 8)	*C. kamtschaticum*,* *C. pectinellum**
Luteolin 7-glucuronide (Group 3)	*C. sieboldi*	Cirsilineol -4′-glucoside and Cirsiliol -4′-glucoside (Group 9)	*C. lineare**
Linarin (Group 4)	*C. purpuratum*, *C. spinosum*		

* Newly listed in this paper.
† By S. Kitamura, G. Murata and M. Hori.

* Part VI in the series "Flavonoids of *Cirsium*". For Part V see N. MORITA, M. FUKUTA and M. SHIMIZU, *Syoyakugaku Zasshi* **19**, 8 (1965).

[1] T. NAKAOKI and N. MORITA, *Yakugaku Zasshi* **79**, 1338 (1959).
[2] T. NAKAOKI and N. MORITA, *Yakugaku Zasshi* **80**, 1296 (1960).
[3] N. MORITA and M. SHIMIZU, *Yakugaku Zasshi* **83**, 615 (1963).
[4] N. MORITA, M. FUKUTA and M. SHIMIZU, *Syoyakugaku Zasshi* **18**, 9 (1964).
[5] N. MORITA, M. FUKUTA and M. SHIMIZU, *Syoyakugaku Zasshi* **19**, 8 (1965).

RESULTS

The glycoside mixture isolated from leaf extracts of *C. lineare*, gave two brown spots in UV on polyamide TLC and PC and were respectively labelled A_o and B_o. They were isolated by silica gel column chromatography. Hydrolysis of A_o yielded D-glucose and an aglycone (A_I). Both A_o and A_I gave a negative Zircon-citric acid test. The UV specta of A_o, needles, m.p. 158–159°, and its aglycone (A_I), yellowish needles, m.p. 208–210°, are presented in Table 2. Neither glycoside nor aglycone showed a bathochromic shift with sodium acetate, indicating 7-*O*-substitution in both. In addition A_o has a free 5-hydroxyl group, from the bathochromic shift with $AlCl_3$.

TABLE 2. UV SPECTRA OF FLAVONE GLYCOSIDES AND THEIR AGLYCONES

Solvent	Cirsilineol (A_I)	4′-Glucoside (A_o)	Cirsiliol (B_I)	4′-Glucoside (B_o)
EtOH	277, 344	279, 336	256, 274, 347	242, 277, 337
+NaOAc	276, 344	279, 335		
+NaOEt	268sh, 341, 410	279, 336	269, 347, 410	242, 274, 333
+$AlCl_3$	260sh, 288, 360	294, 358	262, 283, 368	293, 257

The NMR spectrum of the diacetate (A_{II}) of A_I displayed signals typical of disubstituted *B* ring (Table 3.) The IR spectrum of permethylated A_{III} was found to be superimposable with that of 5,6,7,3′,4′-pentamethoxyflavone. A_I afforded no greenish precipitate with $SrCl_2$, indicating no *o*-hydroxyl group to C-5 in *A* ring.[6] Alkaline decomposition and oxidation with H_2O_2 of A_I both afforded vanillic acid as an acid portion, indicating 3′-OMe and 4′-OH substitution in the *B* ring. A_I is therefore 5,4′-dihydroxy-6,7,3′-trimethoxyflavone. In addition, oxidation with H_2O_2 of the aglycone obtained from the permethylate of A_o afforded vanillic acid, so A_o is cirsilineol 4′-monoglucoside.

TABLE 3. NMR CHEMICAL SHIFTS OF PROTONS OF CIRSILINEOL-DIACETATE* (shifts (ppm) measured in $CDCl_3$)

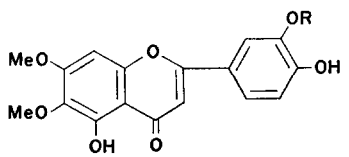
H-2′	H-5′	H-6′	H-8	H-3	OAc	OMe
7·29[d]	7·12[d]	7·35[q]	6·5[s]	6·86[s]	2·34 2·48	3·85, 3·91 3·99

* Tetramethylsilane was the external reference (δ, 0·00).
s—Singlet; *d*—doublet; *q*—quartet.

The UV spectra of B_o, m.p. 215–217°, and its aglycone (B_I), m.p. 281°, are presented in Table 2. The NMR spectrum of the trimethylsilyl ether indicated a similar pattern of aromatic protons as A_o, two methoxyl groups, and a signal for the glucosyl C-1″ proton at 5·05 ppm as 1H. Hydrolysis of B_o with HCl yielded aglycone (B_I) and D-glucose. B_I gave 5,6,7,3′,4′-pentamethoxyflavone with Me_2SO_4 and a triacetate with Ac_2O. The NMR spectrum of the triacetate displayed a similar pattern as A_{II}, except for the number of

[6] M. SHIMIZU and N. MORITA, *Yakugaku Zasshi* **88**, 1451 (1968).

methoxyl and acetoxyl groups. Alkaline decomposition and oxidation with H_2O_2 both yielded protocatechuic acid, while oxidation with H_2O_2 of the aglycone obtained from the permethylate of B_o afforded vanillic acid. B_I is therefore 5,3′,4′-trihydroxy-6,7-dimethoxyflavone and B_o is the 4′-monoglucoside. Since A_I and B_I are novel natural products, we propose the names cirsilineol (I) and cirsiliol (II), respectively.



Cirsilineol I, R = Me
Cirsiliol II, R = H

Using standard techniques, luteolin 7-glucoside was identified in leaf of *C. suffultum*, while pectolinarin and linarin were both found in leaf of *C. kamtschaticum* and *C. pectinellum*.

EXPERIMENTAL*

Plant material. Leaf of *Cirsium lineare* was collected at Hatimandake and *C. suffultum* at Unsen, Kyūshū. *Cirsium kamtschaticum* was collected at Nemuro and *C. pectinellum* at Memanbetsu, Hokkaido, Japan.

Isolation of Cirsilineol 4′-glucoside (A_o) *and Cirsiliol 4′-glucoside* (B_o). Crystals formed on standing of the concentrated MeOH leaf extract of *C. lineare* were combined with those obtained by EtOAc extraction of the aqueous concentrate. This mixture of two components was subjected to column chromatography on silica gel employing $CHCl_3$ and $CHCl_3$–MeOH (19:1) as eluents. The two eluted fractions, recrystallized from MeOH, afforded A_o and B_o.

Properties of A_o *and* B_o. A_o: Almost colorless microneedles, m.p. 158–159°. The dilute acid hydrolyzate reduced the Fehling reagent. PC, R_f 0·91 (60% AcOH), 0·81 (40% AcOH) (Calc. for $C_{24}H_{26}O_{12}.H_2O$: C, 54·96; H, 5·38. Found: C, 55·08; H, 5·68). B_o: Pale yellow needles, m.p. 215–217°, exhibited an orange yellow color with Mg + HCl, yellow with Zn + HCl. (Calc. for $C_{24}H_{26}O_{12}.H_2O$: C, 54·96; H, 5·38. Found: C, 55·08; H, 5·68.) NMR (TMS ether of B_o in CCl_4) δ ppm: 3·96 (6H, OMe × 2), 5·05^m (1H, glucosyl C_1-H).

Cirsilineol (A_I) *and Cirsiliol* (B_I). Hydrolysis of A_o (76·2 mg) with 10% H_2SO_4 afforded A_I (48·2 mg), m.p. 208–210° (Calc. for $C_{18}H_{16}O_7$: C, 62·79; H, 4·68. Found: C, 62·82; H, 4·79). Hydrolysis of B_o with HCl afforded B_I, m.p. 281° (MeOH) (Calc. for $C_{17}H_{14}O_7$: C, 61·80; H, 4·27. Found: C, 61·73; H, 4·38).

Permethylation of A_I *and* B_I (*5,6,7,3′,4′-pentamethoxyflavone* (A_{III}). A mixture of A_I, Me_2SO_4 and K_2CO_3 in MeCOEt was refluxed at 150–170° on oil bath. The $CHCl_3$ soluble portion of the product was chromatographed on silica gel and recrystallized from MeOH, A_{III}, m.p. 173–174°, was obtained. Its IR spectrum was found to be superimposable with that of an authentic specimen. A_{III} was also obtained from B_I.

Permethylate of B_o (B_{III}) *and its hydrolysis* (*formation of Aglycone of* B_{III}). A mixture of B_o, Me_2SO_4 and K_2CO_3 in MeCOEt was refluxed at 170–180° on oil bath; The $CHCl_3$ soluble portion of the product was purified by silica gel chromatography. B_{III} was hydrolysed with 10% H_2SO_4, and from AcOEt soluble portion of the reaction mixture, an aglycone (B_{IV}), m.p. 268–269°, negative to $SrCl_2$ test, was obtained.

Alkali decomposition of B_{IV}. B_{IV} was refluxed with 30% KOH for 1·5 hr, and separated to acid and phenolic portion as usual.

PC R_f	Toluene–HCOOH–HCOOEt (5:4:1)	60% AcOH	*n*-BuOH–pyr.–H_2O (6:4:3)
Acid	0·26	0·83	0·65
Vanillic acid	0·25	0·84	0·65

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* All m.p.s were uncorrected. The sign in NMR data; *m*—multiplet.