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NEW BISFLAVONES FROM PODOCARPUS AND CHAMAECYPARIS PLANTS

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The leaves of Podocarpus plants have been reported to contain kayaflavone (I).1) However, further studies by TLC disclosed2) that they contain several bisflavones. We now report that the leaves of Podocarpus macrophylla (inumaki in Japanese) contain sciadopitysin (II),3) hinokiflavone (III),4) and three new bisflavones, amentoflavone $4'''$-methyl ether (IV, named podocarpusflavone A), 7, $4'''$-dimethyl ether (V, named podocarpusflavone B), and hinokiflavone 7-methyl ether (VI, named neocryptomerin) and that the leaves of P. nagi (nagi in Japanese) contain isoginkgetin (VII)5) and podocarpusflavone A. It is also reported in this paper that the leaves of Chamaecyparis pisifera var. squarrosa (himuro in Japanese) and C.obtusa var. breviramea (chabohiba in Japanese) contain hinokiflavone (III), isocryptomerin (VIII),6) and a new compound, hinokiflavone $7,7''$-dimethyl ether (IX, named chamaecyparin).

A mixture of bisflavones obtained from P. macrophylla was treated with ethanol, in which amentoflavone (XIV) methyl ethers are more soluble than hinokiflavone and its methyl ether. The mixture of amentoflavone methyl ethers was subjected to countercurrent distribution5) to isolate podocarpusflavone A and B and sciadopitysin. On methylation both podocarpusflavone A and B gave amentoflavone hexamethyl ether. The NMR spectra of podocarpusflavone A acetate, m.p. 256-257° and B acetate, m.p. 264-265° showed that they are amentoflavone monomethyl and dimethyl ether respectively. In comparison of chemical shifts of their methyl protons with known biflavonyl methyl ether acetates it is deduced that podocarpusflavone A and B have the structure IV

TABLE

NMR Signals of Methyl Protons in Pyridine

Compounds	Assigned positions in bisflavone nucleus					
	4'	4'''	5	5''	7	7''
Podocarpusflavone A (IV) acetate	(2.05)	3.56	(2.44,	2.52)	(2.22)	(2.16)
Podocarpusflavone B (V) acetate	(2.06)	3.55	(2.48,	2.54)	3.73	(2.16)
Bilobetin (XII) acetate	3.72	(2.15)	(2.47,	2.51)	(2.24)	(2.10)
Ginkgetin (XIII) acetate	3.73	(2.14)	(2.52,	2.52)	3.73	(2.10)
Isoginkgetin (VII) acetate	3.76	3.61	(2.49,	2.55)	(2.26)	(2.13)
Sciadopitysin (II) acetate	3.76*	3.58	(2.50,	2.53)	3.73*	(2.10)
Kayaflavone (I) acetate	3.73	3.60	(2.47,	2.58)	(2.24)	3.80
Amentoflavone (XIV) acetate	(2.03)	(2.14)	(2.45,	2.52)	(2.22)	(2.11)
Amentoflavone hexamethyl ether	3.75	3.59	3.87	4.06	3.75	3.82
Neocryptomerin (VI) acetate		(2.24)	(2.35,	2.47)	3.77	(2.12)
Chamaecyparin (IX) acetate		(2.24)	(2.41,	2.47)	3.75	3.83
Cryptomerin A (X) acetate		3.74	(2.35,	2.45)	(2.24)	(2.13)
Cryptomerin B (XI) acetate		3.76	(2.42,	2.45)	(2.24)	3.85
Isocryptomerin (VIII) acetate		(2.25)	(2.41,	2.45)	(2.25)	3.86
Hinokiflavone (III) acetate		(2.24)	(2.35,	2.45)	(2.24)	(2.12)
III trimethyl ether acetate		3.74*	(2.41,	2.46)	3.77*	3.84
III pentamethyl ether		3.77*	3.81	4.08	3.79*	3.86

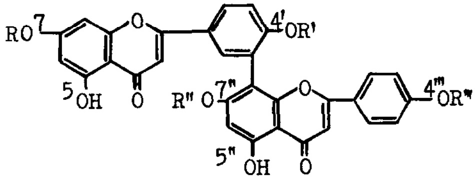
Figures in parentheses show the chemical shifts of acetyl protons.

Spectra were determined on a Hitachi H-60 instrument with tetramethylsilane as internal reference. Chemical shifts are given in δ values (p.p.m.).

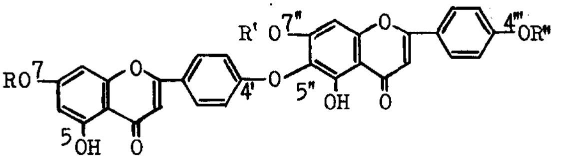
* Assignment is tentative.

and V respectively as shown in the Table.

The mixture of hinokiflavone and neocryptomerin was also subjected to similar countercurrent distribution. Neocryptomerin separated was considered to be a monomethyl ether of hinokiflavone by TLC, but its IR spectrum was not identical with cryptomerin A (X)7) nor isocryptomerin. On the other hand, bisflavone mixtures obtained from the leaves of two kind *Chamaecyparis* plants mentioned above were shown to contain hinokiflavone, isocryptomerin, and a small amount of chamaecyparin, which was considered to be a dimethyl ether of



	R	R'	R''	R'''
I	H	Me	Me	Me
II	Me	Me	H	Me
IV	H	H	H	Me
V	Me	H	H	Me
VII	H	Me	H	Me
XII	H	Me	H	H
XIII	Me	Me	H	H
XIV	H	H	H	H



	R	R'	R''
III	H	H	H
VI	Me	H	H
VIII	H	Me	H
IX	Me	Me	H
X	H	H	Me
XI	H	Me	Me

hinokiflavone but its IR spectrum was not identical with cryptomerin B (XI).[7]

For the elucidation of the structures of neocryptomerin and chamaecyparin the partial demethylation of hinokiflavone pentamethyl ether under a mild condition[8] was performed to give a mixture of hinokiflavone monomethyl and dimethyl ethers. Since the pentamethyl ether has two methoxyl groups at 7 and 7" positions it is interesting to know which is more resistant to demethylation. The partially demethylated mixture was separated by countercurrent distribution followed by recrystallization. The results obtained showed that the mixture consists of a dimethyl ether and two kinds of monomethyl ether. Because 4''',[8] 5, and 5" methoxyl groups are easily demethylated the dimethyl ether should be 7,7"-dimethyl ether. The UV spectrum of this compound shows λ max 271.5 mμ in ethanol, which is unchangeable on addition of sodium acetate.[9] This evidence supports the structure. Fortunately, the IR spectrum of chamaecyparin was identical with that of the dimethyl ether. One of the monomethyl ethers which is less soluble than the other was identified with isocryptomerin (VIII) through their IR spectra. The other compound considered as hinokiflavone 7-methyl ether was identical with neocryptomerin. The NMR spectra of the acetates of the demethylated compounds are also listed in the

Table with those of known hinokiflavone derivatives showing that these structures are reasonable. Therefore, the structures VI and IX were proposed for neocryptomerin and chamaecyparin respectively.

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