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COMPOSITAE

SESQUITERPENES OF *ACHILLEA SIBIRICA*

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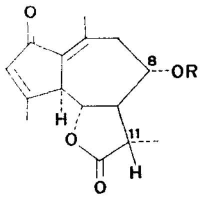
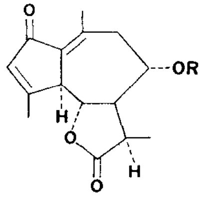
Abstract—(+)-Camphor, chamazulene, desacetylmatricarin and 'compound IIa' were isolated from the title plant. The stereochemistry of 'compound IIa' was determined.

ALTHOUGH the chemical constituents of *Achillea millefolium* L. (Compositae) has been extensively investigated and a large number of compounds have been isolated, little is known of the chemistry of Japanese species of this genus. This paper described the chemical investigation on *A. sibirica* Ledeb. var. *discoidea* Maxim. (Japanese name: Yama-nokogiriso). (+)-Camphor and chamazulene were isolated from the blue oily distillate which was obtained by the steam distillation of the benzene extract of this plant. Two sesquiterpene lactones, desacetylmatricarin (I)[1] and 'compound IIa'[2] (III), were isolated from the benzene extract by means of silica gel column chromatography.

Compound I, m.p. 152–154°, $[\alpha]_D$ +9·9°, had the molecular formula $C_{15}H_{18}O_4$. Acetylation of I yielded an acetate (II) identical with an authentic sample of matricarin. Therefore, compound I was identified as desacetylmatricarin. Compound III, m.p. 161–162°, $[\alpha]_D$ +116°, analysed for $C_{15}H_{18}O_4$. The spectroscopic properties (UV, IR and NMR) were practically identical to those for I except for the optical rotation and for the secondary methyl signal which appeared at δ 1·26 higher than δ 1·44 in I. On acetylation, III afforded an acetate (IV), m.p. 194–195°. The physical data of III were close to those reported[2] for 'compound IIa', an isomer of I. The further identity of III with 'compound IIa' was established by the isomerization of I with potassium *tert*-butoxide to give the equimolecular mixture of I and III.[3] However, the configuration of hydroxyl group of 'compound IIa' has not been discussed hitherto. In the NMR spectra, the signal of H_8-proton in IV appeared at δ 4·77 as a triplet–doublet (J = 10·0, 3·5 Hz) quite similar to the 8β proton in II which appeared at δ 4·80 as a triplet–doublet (J = 10·0, 3·5 Hz). On the basis of these data, it seems reasonable to assume that I, II, III and IV have the same configuration at C-8.



I R = H
II R = Ac



III R = H
IV R = Ac

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[2] E. H. WHITE and R. E. K. WINTER, *Tetrahedron Letters* 137 (1963).
[3] D. H. R. BARTON, J. E. D. LEVISALLES and J. T. PINHEY, *J. Chem. Soc.* 3472 (1962).

EXPERIMENTAL

Isolation of (+)*-camphor and chamazulene.* The title plant was collected in July, 1967 in Mt. Togakushi, Japan. The air-dried whole herbs (6·5 kg) were percolated with benzene (50 kg) at room temp. The extract was concentrated to 1·57 kg. A part (270 g) of the concentrated extract was steam-distilled. The distillate was extracted with benzene to give a blue benzene extract which was washed with 5% $NaHCO_3$ followed by H_2O. Evaporation of the solvent *in vacuo* gave a deep blue oil (4·7 g) which was distilled. A fraction, b.p.$_4$ 40–60°, was purified by sublimation to give (+)-camphor, m.p. 180°. The blue fraction, b.p.$_4$ 90–110°, was converted to the TNB (trinitrobenzene) adduct. Crystallization from EtOH gave the TNB adduct of chamazulene, m.p. 133–134°.

Isolation of desacetylmatricarin and 'compound IIa' The concentrated benzene extract (1·3 kg) was evaporated and the residue (210 g) was extracted with *n*-hexane. The *n*-hexane insoluble powder (86 g) was chromatographed on silica gel (1 kg). The crystalline fractions eluted with benzene–ether (1:1) were combined and rechromatographed with benzene–EtOAc (1:1). The first eluate gave 2·1 g of I. (Found: C, 68·47; H, 6·85%.) Acetylation of I gave an acetate (II), m.p. 194–195°. II was identical to authentic matricarin by the standard methods. The second eluate gave 0·9 g of III. (Found: C, 68·51; H, 6·78%.) III was acetylated to give an acetate (IV), m.p. 194–195°, $[\alpha]_D$ +137°. (Found: C, 67·39; H, 6·55%.)

Isomerization of desacetylmatricarin (I) A mixture of I (54 mg) and *tert*-BuOK (500 mg) in benzene (30 ml) was refluxed for 1 hr. The solution was acidified with 1 N H_2SO_4 and extracted with benzene. The organic layer was dried and evaporated. The residue was found to be the mixture of I (80%) and III (20%) by the analyses of NMR and TLC

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SENKIRKINE, A PYRROLIZIDINE ALKALOID FROM *FARFUGIUM JAPONICUM*[*]

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Plant. Farfugium japonicum Kitam. (Tsuwabuki in Japanese)—tribe Senecioneae—Compositae.

Uses. Folk medicine for suppuration and eczema.[1]

Previous works. On the aldehydes[2] and phenolic products.[3]

THE MeOH EXTRACTS of the roots and leaves were shaken with 2 N H_2SO_4, respectively. Each acidic solution was reduced with zinc dust and filtered. The filtrate was made alkaline

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[*] Part III in the series "Studies on Constituents of Crude Drugs". For Part II see T. FURUYA and M. HIKICHI, *Phytochem* **10**, 2217 (1971).

[1] T. KARIYONE and Y. KIMURA, *Wakan Yakuyoshokubutsu* (A Dictionary of Japanese and Chinese Medicinal Plants), p. 23, Hirokawa Publishing, Tokyo (1965).

[2] T. KOSUGE and M. YOKOTA, *Yakugaku Zasshi* **83**, 422 (1963).

[3] S. SAKAMURA, reported at *The 7th Symposium on Chemistry of Natural Phenolic Compounds*, Sendai, Japan (November 1970).