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CARBON-13 NMR SPECTRAL ASSIGNMENTS OF CUCURBITACIN AGLYCONES

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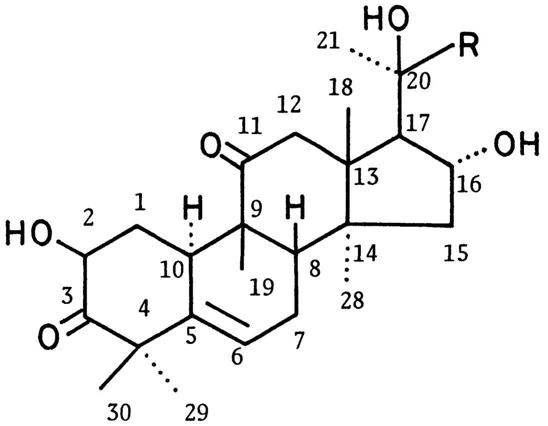
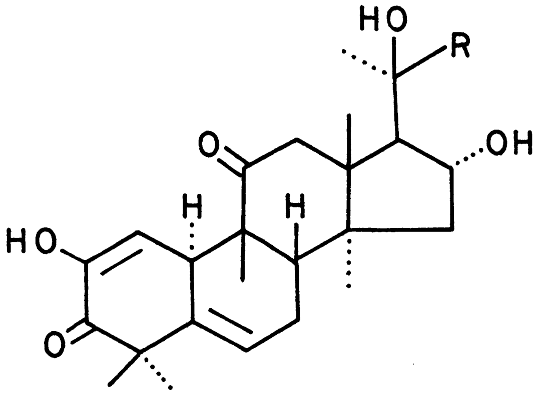
Assignments of ^{13}C signals of the several cucurbitacins (1)~(7), most of which were isolated from Anagallis arvensis L. (Primulaceae), were performed and the general feature of the chemical shifts was described.

Cucurbitacin triterpenoids are well known as bitter principles1) of the plants such as Cucurbitaceae and Cruciferae, and have been also received attention owing to their biological activities.2,3) Previously we reported4) the first isolation of two cucurbitacin glucosides from Anagallis arvensis L.(Primulaceae) as the major bitter principles. The essential advantage of the ^{13}C NMR spectra for the structure elucidation of these glucosides led us to undertake the study on the ^{13}C NMR spectra of the various cucurbitacin aglycones to clarify the general feature of ^{13}C chemical shifts for cucurbitacins. Here we describe the assignments of the ^{13}C signals of several typical cucurbitacin aglycones (1)~(7), most of which were isolated during the further investigation of Anagallis arvensis L. and some of which were obtained by chemical conversion.

Repeated silica gel column-chromatography of the ethyl acetate soluble part of the methanol extract of Anagallis arvensis L. gave (1)(cucurbitacin D),2) (2)(cucurbitacin B),5) (3)(cucurbitacin R)6) and (5)(cucurbitacin L),7) in addition to (7)(cucurbitacin E)8,9) which was reported in the previous paper.4) The compound (4)(dihydrocucurbitacin B)10) and (6)(dihydrocucurbitacin E)11) were obtained by catalytic hydrogenation (Pd-C) of (2) and (7), respectively.





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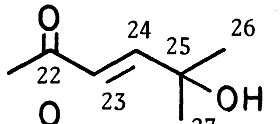

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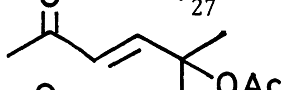

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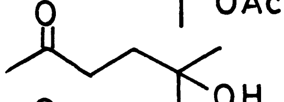

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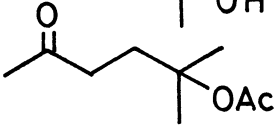
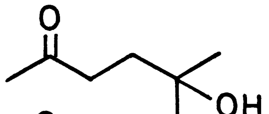
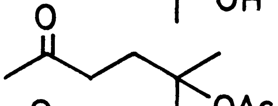


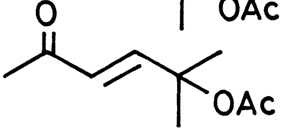
(5) R =



(6) R =



(7) R =



The ^{13}C NMR spectra of these compounds were thus examined. Initially signal assignments were performed by means of chemical shift rules[12)] and ^{1}H single frequency off-resonance decoupling experiments. Furthermore assignments were helped by chemical shift comparisons of pairs of compounds [for example : (1) and its dihydro derivative (3); (1) and its acetate (2)], consideration of esterification shift,[13,14)] and literature data on partially related structures.[15)] The results are shown in the Table.

As for the side chain carbons, the characteristic acetylation shifts are particularly of interest : the signals at C-24, C-25, C-26 and C-27 positions are shifted on going from the tertiary alcohols (1), (3) and (5) to their acetates (2), (4) and (6), respectively. In the case of (2) which is an acetate of the allyl alcohol (1), the α-carbon signal (C-25) is deshielded by +9.4 ppm, while the corresponding signals in (4) and (6) which are the acetates of the saturated alcohols (3) and (5) are more strongly deshielded (ca. +12 ppm). The β-carbon signals (C-24, C-26 and C-27) are shifted by -3.1~-3.9 ppm in every acetates, Table ^{13}C NMR Chemical Shifts[a] of Cucurbitacins.

Carbon	(1)	(2)	(3)	(4)	(5)	(6)	(7)[b]
C-1	36.8	36.9	36.9	36.8	115.7	115.6	115.8
2	72.3	72.0	72.5	72.2	147.2	147.2	147.2
3	213.0	213.1	213.0	212.1	198.7	198.7	198.7
4	48.5	48.6[d]	48.9	48.6	48.7[d]	48.7[d]	48.6
5	141.4	141.4	141.6	140.9	137.7	137.7	137.9
6	120.5	120.3	120.3	119.8	120.5	120.4	120.6
7	24.1[c]	24.1[c]	24.2[c]	24.1[c]	23.9[c]	23.9[c]	24.0[c]
8	34.2	34.2	34.4	34.2	35.2	35.4	35.3
9	48.5	48.8[d]	48.9	48.6	48.6	48.5[d]	48.6
10	42.9	43.1	42.8	42.7	42.0	42.1	42.3
11	213.2	213.3	213.5	212.5	213.4	213.4	213.5
12	49.1[c]	49.6[c]	49.2[c]	49.2[c]	49.2[c]	49.2[c]	49.4[c]
13	50.9	50.1	51.1	50.8	49.5[g]	49.5[g]	49.4[g]
14	50.9	50.1	51.1	50.8	51.0[g]	51.0[g]	51.0[g]
15	46.2[c]	46.3[c]	46.0[c]	46.2[c]	46.5[c]	46.5[c]	46.6[c]
16	70.3	70.9	70.4	70.1	70.3	70.3	70.9
17	59.2	59.8	59.1	58.9	58.8	59.0	59.7
20	79.6	79.7	80.3	79.9	80.0	80.0	79.7
22	204.2	204.4	216.3	214.4	215.7	214.8	204.1
23	120.8	122.5	32.7	32.2	32.6	32.1	122.6
24	155.5	149.9 (-5.6)[f]	38.5	35.3(- 3.2)	38.4	35.2 (- 3.2)	150.1
25	70.3	79.7 (+9.4)	69.3	81.4(+12.1)	69.0	81.6 (+12.6)	79.7
26	29.7	26.2[e](-3.5)	29.9	26.0(- 3.9)	29.8[e]	25.9[e](- 3.9)	26.3[e]
27	29.7	26.6[e](-3.1)	29.9	26.0(- 3.9)	30.0[e]	26.1[e](- 3.9)	26.6[e]
28	25.4	25.4	25.5	25.5	25.4	25.5	25.4
29	29.7	29.6	29.5	29.4	28.0	28.0	28.1
the other CH_3	21.8	21.7	22.0	21.8	20.7	20.7	20.7
(18,19,21,30)	20.1	20.5	20.3	20.3	20.3	20.3	20.5
	20.1	19.9	20.3	20.0	20.2	20.2	20.2
	18.9	18.9	18.9	19.0	18.4	18.4	18.5
$-O\underline{C}OCH_3$	---	169.9	---	169.6	---	170.0	169.7
$-OCO\underline{C}H_3$	---	21.7	---	22.1	---	22.2	21.7

[a] ^{13}C NMR spectra were taken with Varian NV-14 spectrometer (15.1 MHz) for (1), (2), (3) and (7), and JEOL FX-60 spectrometer (15.0 MHz) for (4), (5) and (6) in C_5D_5N with TMS as an internal reference.

[b] The data for (7) were already reported in the previous paper.4)

[c-e,g] Assignments may be reversed in each column.

[f] Values in parentheses indicate the differences of the chemical shifts of each carbon between the acetate and its desacetyl derivative; the acetylation shift.

except for the C-24 olefinic carbon signal (-5.6 ppm) in (2). Although the esterification shift is widely observed in various primary and secondary alcohols, examples of tertiary alcohols are limited to simple compounds.[14] The presence of the C-C double bond in the side chain gives rise to the different effect on the adjacent C-25 carbon. Low field shift (+1.0 ppm) is recognized in the case of the alcohol (1), while high field shifts (-1.7 and -1.9 ppm) are observed in the acetates (2) and (7), when the signals are compared with those of the 23,24-dihydro counterparts.

With respect to the carbons due to the tetracyclic skeleton, the chemical shifts are closely related to each other among the same series of the compounds, (1)~(4) and (5)~(7), respectively. The effect on neighbouring carbons due to the presence of the C-C double bond in the ring A (diosphenol) are apparently recognized at C-5 position (-3.2~-3.9 ppm) in (5), (6) and (7) as compared with the 1,2-dihydro derivatives, whereas the C-4, C-9 and C-10 positions remain almost unaffected.

The ^{13}C NMR data presented in this paper afford a useful information for the structure elucidation in the field of cucurbitacins and the related triterpenes.

REFERENCES

1. D.Lavie and E.Glotter, Fortschr.Chem.Org.Naturst., 29, 307(1971).
2. S.M.Kupchan, C.W.Sigel, L.J.Guttman, R.J.Restivo and R.F.Bryan, J.Amer.Chem.Soc., 94, 1353(1972).
3. S.M.Kupchan, G.Tsou and C.W.Sigel, J.Org.Chem., 38, 1420(1973).
4. Y.Yamada, K.Hagiwara, K.Iguchi and S.Suzuki, Tetrahedron Letters, 1977, 2099.
5. W.T.de Kock, P.R.Enslin, K.B.Norton, D.H.R.Barton, B.Sklarz and A.A.Bothner-By, J.Chem.Soc., 1963, 3828.
6. M.M.Rao, H.Meshulam and D.Lavie, J.C.S.Perkin I, 1974, 2252.
7. P.R.Enslin and K.B.Norton, J.Chem.Soc., 1964, 529.
8. D.Lavie and S.Szinai, J.Amer.Chem.Soc., 80, 707(1958).
9. The presence of such many kinds of cucurbitacins in Primulaceae is interesting in view of the chemotaxonomy.
10. R.W.Doskotch, M.Y.Malik and J.L.Beal, Lloydia, 32, 115(1969).
11. R.Gmelin, Arzeneimittel-Forsch., 14, 1021(1964).
12. J.B.Stothers, " Carbon-13 NMR Spectroscopy ", Academic Press, New York(1972).
13. Y.Terui, K.Tori and N.Tsuji, Tetrahedron Letters, 1976, 621.
14. D.E.Dorman, D.Bauer and J.D.Roberts, J.Org.Chem., 40, 3729(1975);
    S.W.Pelletier, Z.Djarmati and C.Pape, Tetrahedron, 32, 996(1976).
15. G.Lukacs, F.Khuong-Huu and C.R.Bennett, Tetrahedron Letters, 1972, 3515;
    H.Hikino, T.Okuyama, C.Konno and T.Takemoto, Chem.Pharm.Bull., 23, 125(1975);
    A.A.Chalmers, C.P.Gorst-Allman and L.P.L.Piacenza, Tetrahedron Letters, 1977, 1665.

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