Biochemical Studies on "Bakanae" fungus

Part XXXX. Chemical Structure of Gibberellins. X

Sirs:

In this communication, the further evidences are presented which make sure of the assumption proposed in our previous paper¹⁾ on the relation between gibberellin A₁ and gibberellic acid.

As already described, methyl gibberellate gives two kinds of compounds by the catalytic hydrogenation with Adams' catalyser, uptaking 1.8 moles of hydrogen. One is dihydrogibberellin A₁ methyl ester, a mixture of two epimers, in 15-20% yield and the other is a hydrogenolysis product, C₂₀H₂₈₋₃₀O₆, in 60% yield.

Now, when free gibberellic acid is subjected to the same catalytic reduction, the following four products are separated through the partition chromatography of silica gel:

1) an undetermined compound, d.p. 176-80°, in less than 5% yield.

2) monocarboxylic acid, C₁₉H₂₆O₆, d.p. 270-2°, in 35-40% yield, which is identical with dihydrogibberellin A₁, a mixture of two epimers, being confirmed by infrared spectrum and mixed melting point.

3) dicarboxylic acid, C₁₉H₂₈O₆, d.p. 290-5°, in 20% yield, which is a hydrogenolysed product.

4) dicarboxylic acid, C₁₉H₂₆O₆ · 1/2 H₂O, d.p. 184-6°, in 30% yield, which is a hydrogenolysed product.

The fact that dihydrogibberellin A₁ is obtained in a fairly good yield from gibberellic acid supports our assumption concerning the relation between gibberellin A₁ and gibberellic acid.

Moreover, when gibberellin A₁ methyl ester and methyl gibberellate are treated with an

excess of lithium aluminum hydride in boiling tetrahydrofuran for 24 hours, C₁₉H₃₂O₅ (A₁ Li product), m.p. 208-10°, from gibberellin A₁ methyl ester and C₁₉H₃₀O₅ (G. acid Li product) m.p. 208-10°, from methyl gibberellate are obtained, respectively. On hydrogenation with Adams' catalyser, the A₁ Li product absorbs no hydrogen, the original substance being recovered, and the G. acid Li product absorbs 1.5 moles of hydrogen, yielding the identical substance with the A₁ Li product.

These evidences lead us to the conclusion that gibberellic acid has the same configuration with gibberellin A₁, except that gibberellic acid has one more carbon-carbon double bond besides exocyclic methylene in the D ring, the existence of such a methylene group in gibberellin A₁ and gibberellic acid being reported in previous communication^{2,3)}.

As the close similarity of structure of gibberellin A₁ and gibberellic acid is already confirmed, we intended to elucidate the structure of gibberellic acid, on which the structure (I) was proposed by Cross et al. tentatively. We have now reached a different conclusion from Cross' structure of ring A, especially the position of the lactone ring.

A₁ Li product and G. acid Li product do not consume periodate in either alkaline or acidic condition for 24 hours. These results

2) Y. Seta, H. Kitamura, N. Takahashi and Y. Sumiki: *Bull. Agr. Chem. Soc. Japan*, **21**, 73 (1957).

3) B.E. Cross, J.F. Grove, J. MacMillan and T.D.C. Mulholland: *Chem. and Ind.*, **36**, 954 (1956).

1) H. Kitamura, Y. Seta, N. Takahashi and Y. Sumiki: *Bull. Agr. Chem. Soc. Japan*, **21**, 71 (1957).

clearly indicate that lactone alkyl oxygen is not located at the vicinal position to the original secondary hydroxyl group in A ring.

On the other hand, on alkali treatment* of gibberellin A₁, dihydrogibberellin A₁, isogibberellin A₁ and gibberellic acid, each of them consumes two moles of alkali. Then, the solution back-titrated to pH 8-9 was treated with potassium dimesoperiodate solution at the same pH.

In this experiment, both dihydrogibberellin A₁ and isogibberellin A₁⁴⁾ which is an isomer obtained by treating gibberellin C with alkali, do not consume periodate for a period of 24 hours. However, gibberellin A₁ consumes about one mole of periodate rather slowly while gibberellic acid consumes more than 4 moles of periodate very rapidly. We, therefore, examined the change caused by alkali treatment under the same condition* as described above, excluding periodic acid oxidation. The main products recovered by acidifying the alkali treated solution of gibberellin A₁, are gibberellin A₁ in 10% yield and an isomer of gibberellin A₁ in 50% yield. The latter is a different compound from pseudogibberellin A₁ and does not consume periodate under the above condition. In connection with the fact that dihydrogibberellin A₁ and isogibberellin A₁ do not consume periodate, it might be considered that a small, not the main portion of the alkali treated product, which cannot be isolated in a pure state through the partition chromatography

of silica gel, consumes periodate.

While, on the same alkali treatment and acidification, gibberellic acid gives amorphous dicarboxylic acid, C₁₉H₂₆O₈, d.p. 152-4°, which readily consumes periodate in acid and alkaline conditions. Moreover, this substance absorbs only one mole of hydrogen, not two moles, by catalytic hydrogenation. The elementary analytical datum shows that two moles of water are added to the original formula, one of them being used in hydrolysis of the lactone ring. The result of catalytic reduction shows that one of the two double bonds present in gibberellic acid is absent in amorphous dicarboxylic acid. Consequently, we conclude that dicarboxylic acid is not a simple hydrolysis product of the lactone ring but a secondarily changed product—perhaps hydration of the double bond—and thus, the newly introduced hydroxyl group is vicinal to the lactone alkyl oxygen or original secondary hydroxyl group.

With regard to the position of the original secondary hydroxyl group in A ring, this will be reported in the coming near future.

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*This condition is more vigorous than that in the case of obtaining pseudogibberellin A₁ from gibberellin A₁, and under the latter condition, the lactone ring of gibberellin A₁ is not opened.

4) N. Takahashi, Y. Seta, H. Kitamura, A. Kawarada and Y. Sumiki: *Bull. Chem. Soc. Japan*, **21**, 75 (1957).