Tetrahedron Letters No.7, pp. 597-601, 1967. Pergamon Press Ltd. Printed in Great Britain.

THE STRUCTURES OF CAMELLIAGENIN A, B, AND C OBTAINED FROM CAMELLIA JAPONICA L.

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(Received 8 November 1966)

The presence of a saponin in the seeds of Camellia japonica L. had been reported for a long time. In 1953-4, Ishidate and Takamura[1] isolated a saponin, named camellia saponin, and showed that the saponin was composed of camellia-sapogenol, $C_{30}H_{50}O_4$, m.p. 290-292.5, $[\alpha]_D$ + 22, tiglic acid, arabinose, glucose, and an uronic acid. They also reported that the sapogenol possessed four hydroxyl groups, two of which were in a 1,3-glycol moiety, and suggested that the sapogenol might belong to β-amyrin group of triterpenoids.

We have succeeded in the isolation of three sapogenins, named camelliagenin A, B, and C[2], from the hydrolysate of the saponin from the seeds of Camellia japonica L. as follows:

Camelliagenin A (I) m.p. 290-293°, $C_{30}H_{50}O_4$, $[\alpha]_D$ +20.05° (EtOH)

Camelliagenin B (II) m.p. 195-204°, $C_{30}H_{48}O_5$, $[\alpha]_D$ +47.55° (EtOH)

Camelliagenin C (III) m.p. 280-283°, $C_{30}H_{50}O_5$, $[\alpha]_D$ +25.35° (EtOH)

Camelliagenin A was proved to be identical with the sapogenol obtained by Ishidate and Takamura[1].

IR and NMR spectra of I and the formation of tetraacetate revealed that the all four oxygen atoms in I exist in hydroxyl groups, one primary and the other three secondary. Camelliagenin A easily forms the isopropylidene derivative(IV), m.p. 234-236°,

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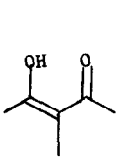
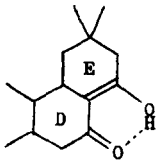
* All the compounds shown by molecular formulae gave satisfactory analytical results.



(A)



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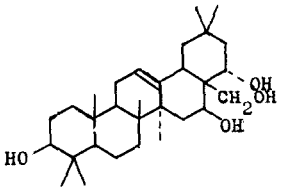

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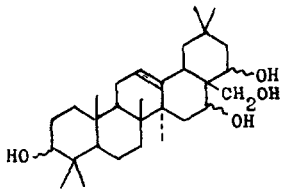
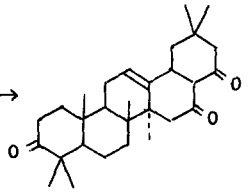


(D)

(C) →



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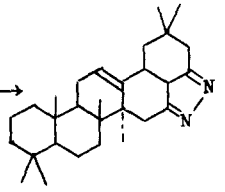

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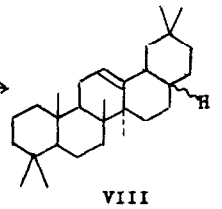
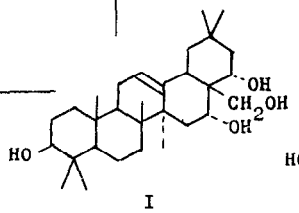


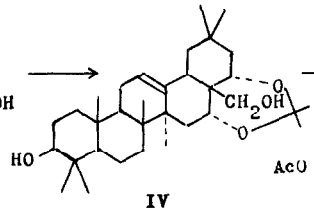
VIII

Tetra-acetate

XV



I



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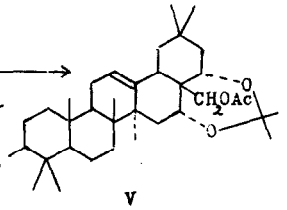

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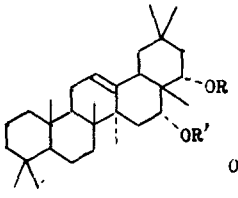
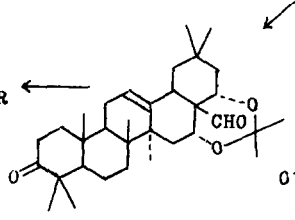
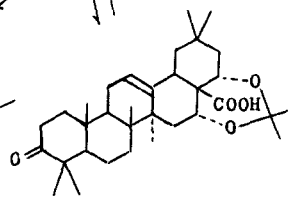


XI $\begin{matrix}R\\R'\end{matrix}\Big\} = \diagup\!\!\!\diagdown \begin{matrix}CH_3\\CH_3\end{matrix}$

XII R = R' = H



IX



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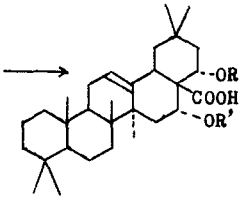
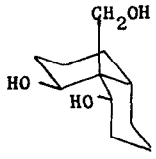
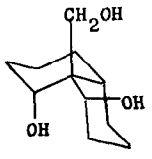


XIII $\begin{matrix}R\\R'\end{matrix}\Big\} = \diagup\!\!\!\diagdown \begin{matrix}CH_3\\CH_3\end{matrix}$

XIV R = R' = H



(E)



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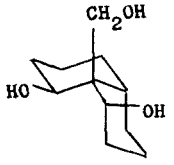
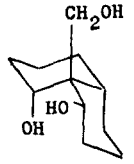


(G)



(H)

$C_{33}H_{54}O_4$, which was further characterised by the diacetate(V), m.p. 193-195°, $C_{37}H_{58}O_6$. The glycol was assumed to be a 1,3-glycol, since I was stable for periodate oxidation. The oxidation of IV with chromium trioxide afforded the keto-aldehyde(IX), m.p. 223-225°, $C_{33}H_{50}O_4$, NMR 9.42 ppm(1H), and the keto-carboxylic acid(X), m.p. 240-246°, $C_{33}H_{50}O_5$. The Wolff-Kishner reduction of IX gave the isopropylidene derivative(XI), m.p. 222°, $C_{33}H_{54}O_2$, which was hydrolysed into the diol(XII), m.p. 243°, $C_{30}H_{50}O_2$. Similarly, the isopropylidene-carboxylic acid(XIII), m.p. 237-239°, $C_{33}H_{52}O_4$, and the dihydroxy-carboxylic acid(XIV), m.p. 242°, $C_{30}H_{48}O_4$, were obtained from X. These reactions characterized the nature of the hydroxyl groups in I.

The oxidation of V with selenium dioxide in boiling acetic acid easily led to the formation of a heteroannular diene, m.p. 220-223°, UV λ_{max}^{EtOH} 243, 251, 262 mμ. The fact, along with the presence of seven tertiary methyl signals in the NMR spectra of I and the derivatives, suggested that I might be olean-12-ene derivative. This has firmely established by the chromium trioxide oxidation of camelliagenin A(I) itself, The product, m.p. 258°, was proved to be nor-triketone(VI), $C_{29}H_{42}O_3$, M^+ 438, IR 1710, 1620 cm^{-1}, UV λ_{max}^{EtOH} 291 mμ, λ_{max}^{KOH} 310 mμ, NMR 15.15 ppm(1H). These spectral data and the positive ferric chloride reaction of VI shows the presence of a β-diketone group, which exists the enolised form(A) to form intramolecular hydrogen bond. The β-diketone system could be placed only in rings D and E as shown in the formula(B). A positive Zimmerman reaction of IX and X suggested the presence of a carbonyl group in C-3 position[4]. Thus the nortriketone (VI) might be 28-nor-olean-12-ene-3,16,22-trione. This compound had been known as the oxidation product of chichipegenin(C)[5] and the identity was established by a mixed fusion and infrared spectra**. Now the structure of camelliagenin A(I) should be expressed by the formula(D). The loss of C-28 in the course of the oxidation will be explicable by the formulation[6].

The Wolff-Kishner reduction of VI gave a compound, m.p. 175°, assumed to be expressed by the formula(VII), and the C_{29}-hydrocarbon(VIII), m.p. 148°.

The formation of the keto-aldehyde(IX) and the keto-acid(X) from IV confines the location of the acetonide group between C-16 and C-22 hydroxyl groups. Of the four isomers (E - H) concerning with the hydroxyl groups, the acetonide formation is possible in E and H,

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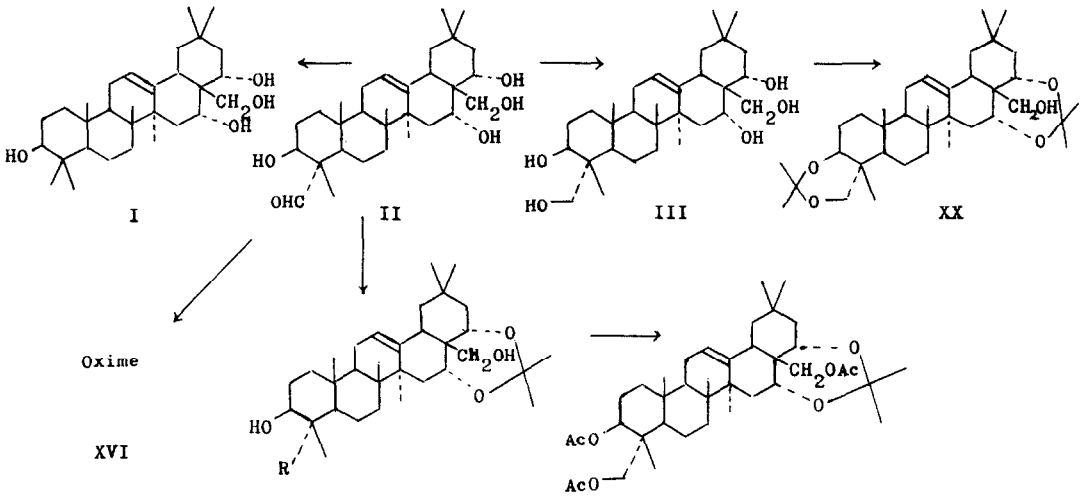
** The identification has been carried out by the courtesy of Prof. C. Djerassi, Stanford University.



in which the former should be excluded, because of the nonidentity of I with chichipegenin (C). Since lithium alminum hydride reduction of X regenerated IV, the orientation of the hydroxyl group at C-3 was determined as equatorial(3β)[7]. The chemical shifts and coupling constants of the hydrogens attached to the carbon atoms bearing these hydroxyl groups in I and the derivatives are all consistent with these assignment of the configuration of the hydroxyl groups.

Accordingly, camelliagenin A can be formulated as 3β, 16α, 22α, 28-tetrahydroxyolean-12-ene(I).

The NMR and IR spectra of camelliagenin B(II) and C(III) revealed the presence of an aldehyde group and an additional hydroxyl group in II and III, respectively, besides four hydroxyl groups in I. The interrelationship was firmly established by the Wolff-Kishner reduction of II to I and lithium aluminum hydride reduction of II to III, thus proving the presence of an aldehyde group in II and a carbinol group in III instead of one of the seven methyl groups in I. The formation of the diisopropylidene derivative (XX), m.p. 160°, $C_{36}H_{58}O_5$, from III indicated the presence of the carbinol group at 4α or 4β position. II formed an oxime(XVI), m.p. 232-235°, $C_{30}H_{49}O_5N$, and the monoisopropylidene derivative(XVII), $C_{33}H_{52}O_5$. Lithium aluminum hydride reduction of XVII afforded

the acetonide of pentaol(XVIII), which formed the triacetate(XIX).

The NMR spectra(9.24 ppm(CHO) in II and 3.76 ppm(CH_2OAc) in XIX) showed that these groups at C-4 position must have α-orientation[8].

Thus camelliagenin B and C must be represented by 23-oxo-3β,16α,22α, 28-tetrahydroxy-(II) and 3β,16α,22α,23,28-pentahydroxy-olean-12-ene(III) respectively.

Acknowledgment, The authors wish to express their appreciation to Prof. T. Okamoto, Tokyo University, for supplying Plant materials; to Dr. K. Takamura, Chugai Co. Ltd., Prof. M. Fujita, Tokyo College of Pharmacy, Prof. M. Nagasawa, Tokyo College of Science, Dr. Y. Suzuki, Kowa Co. Ltd, and Dr. S. Natori, National Institute of hygenic Sciences, for continued interest and encouragement; to Prof. S. Shibata and Dr. O. Tanaka, Tokyo University, for their suggestions; to Dr. M. Yamazaki, National Institute of Radiological Sciences, Dr. T. Miki, Takeda Co. Ltd., Prof. T. Sasaki, Nagoya University, and Dr. Y. Kawasoe, National Cancer Center, for their valuable assistance in performing instrumental measurements.

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