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THE CHEMICAL CONVERSION OF ENMEIN INTO ent-15-KAURENE AND ent-16-KAURENE

Eiichi Fujita*[1], Tetsuro Fujita, Yoshimitsu Nagao,
Hajime Katayama, and Masayuki Shibuya

Institute for Chemical Research, Kyoto University
Uji, Kyoto-Fu, Japan

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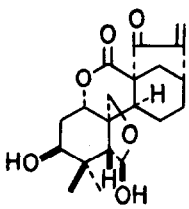
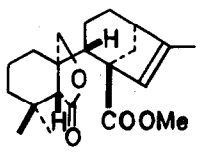
We have been trying some chemical conversions of enmein[1](I), a bitter diterpenoid of Isodon species, into other diterpenoids. As a key reaction, the acyloin condensation[1,3] with an unsaturated lactone ester II[2] derived from enmein was repeatedly carried out. The investigation of the reaction condition led to a success in getting the desired compound as a major product, that is, we could find the good procedure for getting acyloin III, m.p. 167.5-168° or 229-234°, or diol IV, m.p. 156°. Hydrogenation of III and IV gave the known dihydro-derivatives, V[1] and VI[1], respectively. The by-products of the acyloin reaction includes ketone VII, acyloin VIII, and triols IX and X*[2].



I



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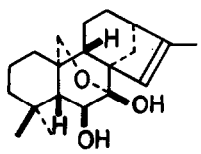

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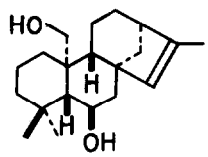

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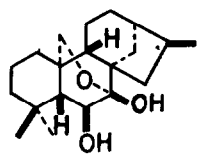
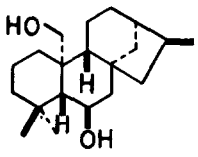


V

*[1] To whom correspondence should be addressed.

*[2] Structural elucidations of these products and detailed investigation of the acyloin condensation will be reported elsewhere.



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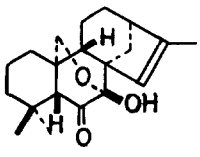

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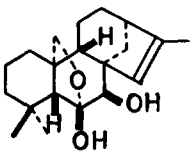
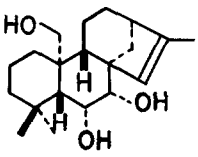


VIII



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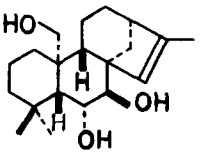
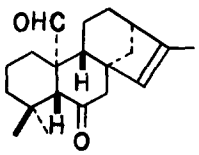
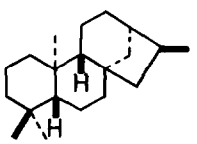


X

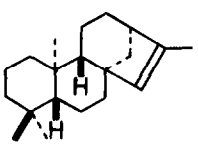
Acyloin III was useful for another chemical conversion.*[3] Now, diol III on Jones oxidation gave keto-aldehyde XI, m.p. 113-115°, [IR $\nu_{max}^{CHCl_3}$: 2735, 1710 cm^{-1}, NMR δ^{CDCl_3}: 2.43(1H, s, C-5-H), 2.91, 2.25(each 1H, AB-type, J = 12.5 Hz, C-7-H_2), 10.5 ppm(1H, s, C-20-CHO)] in a good yield. The latter was subjected to the Nagata's modification[4] of Wolff-Kishner reduction to give ent-kaurane*[4] (XII)[1], m.p. 86°, in 29% yield. Subsequently, XI was heated at 160-170° with 98% hydrazine and sodium in anhydrous MeOH for 10 hours in a sealed tube.[5] The reaction gave a mixture of ent-15-kaurene*[4](XIII), ent-16-kaurene*[4](XIV), and ent-kaurane(XII)(3 : 1 : 1) in a very low yield, which was checked vaporphase-chromatographycally.



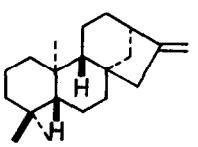
XI



XII



XIII



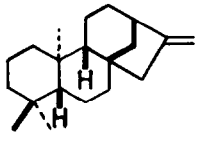
XIV

*[3] See the following communication.

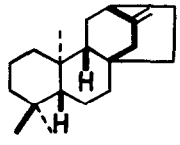
*[4] (-)-Kaurane, (-)-kaurene, and (-)-isokaurene are named ent-kaurane, ent-16-kaurene, and ent-15-kaurene, respectively, in accordance with a proposal for nomenclature of cyclic diterpenes.(J.W.Rowe, in preparation.)

Finally, XI was heated with anhydrous hydrazine and sodium at 180-190° for 24 kours[6] to give a mixture of XIII, XIV, and XII(5 : 2 : 3) as crude crystalline needles in a fairly good yield. They were effectively separated by a column chromatography on silica gel impregnated with 2.5% silver nitrate using petroleum ether for elution. The first eluate was isolated as crystals, m.p. 86°, which proved to be identical with ent-kaurane(XII), and the second eluate was purified to give crystals, m.p. 49-50°, which proved to be identical with ent-16-kaurene(XIV). The yields of XII and XIV were 10% and 5%, respectively. The last eluate was isolated as crystals, m.p. 67.5-68.5°, which proved to be ent-15-kaurene(XIII) by comparison with the authentic sample of 15-kaurene.[6] The yield of XIII was 18%.

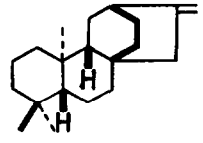
The chemical conversions of enmein into ent-kaurane(XII)[1] and ent-16-kaurene*[3](XIV) have been achieved by us. The present work constitutes another novel route of enmein into them.



XV



XVI



XVII

Recently, McCrindle et al.[7] succeeded in a formal conversion of ent-16-kaurene(XIV) into ent-phyllocladene(XV), atisirene(XVI), and neoatisirene(XVII). Thus, the route from enmein into these compounds was connected.

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