

TERPENOIDS. XI

THE STRUCTURE OF NEZUKONE

Y. Hirose, B. Tomita and T. Nakatsuka

Faculty of Agriculture, University of Tokyo, Tokyo, Japan

(Received 10 August 1966; in revised form 21 September 1966)

The petroleum-ether soluble part of the methanol extract from the wood of Thuja standishii Carr. (the Japanese Nezuco tree) has been investigated and the occurrence of a kind of carbonyl compound, which gave a characteristic red semicarbazone, in addition to carvacrol, α -, β -thujaplicins, β -sitosterol and a paraffin hydrocarbon has previously been reported¹⁾. This paper deals with the elucidation of the structure (I) for that carbonyl compound, named nezukone.

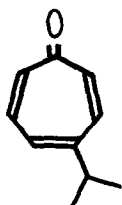
Nezukone purified by distillation (b.p. 127-128° at 5 mmHg, n_D^{25} 1.5691, d_{16}^{16} 1.0170, $[\alpha]_D \pm 0^\circ$) was a pale yellow liquid giving a positive tetranitromethane test and was quite unstable, being colored rapidly to red brown on exposure to light and air. As mentioned above, nezukone afforded red semicarbazone, $C_{11}H_{15}ON_3$, m.p. 174-176°, λ_{max}^{EtOH} 325 m μ ($\log \epsilon$ 4.55) and 385 m μ (shoulder, $\log \epsilon$ 3.25), ν_{max}^{KBr} 3520, 3250, 1690, 1570, 1130, 825 and 790 cm^{-1} , which was suggested to be a semicarbazone of a highly unsaturated carbonyl compound.

On hydrogenation in the presence of palladium-carbon catalyst in ethanol, the red semicarbazone absorbed hardly any hydrogen and, on the other hand, on hydrogenation in the presence of Adams' catalyst it absorbed three moles of hydrogen to give a colorless hexahydro semicarbazone, $C_{11}H_{21}ON_3$, m.p. 165-166°, which gave a negative tetranitromethane test, thereby establishing the molecular formula for nezucone, $C_{10}H_{12}O$, and the presence of one ring in it.

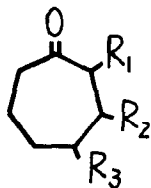
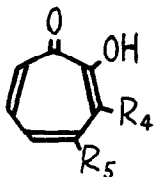
On hydrolysis of the red semicarbazone with phthalic anhydride, nezucone was able to be regenerated. Ultraviolet absorptions of the regenerated nezucone at $\lambda_{\text{max.}}^{\text{EtOH}}$ 230 $m\mu$ ($\log \epsilon$ 4.47) and 310-315 $m\mu$ ($\log \epsilon$ 4.17) and infrared absorptions at $\nu_{\text{max.}}^{\text{liq.}}$ 3520, 1635, 1580 (very strong), 1457, 1237 and 864 cm^{-1} suggested the presence of the tropone ring in nezucone²⁾⁻⁴⁾. Though infrared spectrum showed no clear absorptions due to isopropyl group, the n.m.r. spectrum (60 Mc) confirmed the presence of one isopropyl group (6H, an asymmetric doublet centered at 1.21 δ with $J=7.0$ c.p.s. and 1H, a clear heptet centered at 2.70 δ with $J=7.0$ c.p.s., typical for free rotating isopropyl group of A_6B type). Another five protons in nezucone appeared in the region of 6.5-7.2 δ like substituted aromatic ring protons.

Hydrolysis of the saturated semicarbazone with phthalic anhydride afforded hexahydronezucone, $C_{10}H_{18}O$, b.p. 62° at 1 mmHg, the infrared spectrum of which exhibited strong bands at 1699 and 1415 cm^{-1} confirming the presence of a $-CH_2CO-$ grouping in a seven membered ring⁵⁾. Infrared absorption bands at 1395, 1373 (doublet) and 1167 cm^{-1} and the n.m.r.

spectrum (6H, an asymmetric doublet at 0.88δ with $J=6.0$ c.p.s.) indicated the presence of an isopropyl group. From above results, only three structures, 2-, 3- and 4-isopropylcycloheptanones, (II), (III), (IV), remained to be considered as the structure of hexahydronezukone. Since integration of the appropriate region in the n.m.r. spectrum ($2.1-2.6\delta$) demonstrated that there were four protons adjacent to carbonyl group, the structure (II) was excluded.



(I)

(II) R_1 =isopropyl, $R_2=R_3$ =H(III) R_2 =isopropyl, $R_1=R_3$ =H(IV) R_3 =isopropyl, $R_1=R_2$ =H(V) R_4 =isopropyl, R_5 =H(VI) R_5 =isopropyl, R_4 =H

It was reported that the semicarbazone of 3-isopropylcycloheptanone melted at 190° ⁶⁾, and that there were two kinds of semicarbazone for 4-isopropylcycloheptanone, one melting at $139-140^\circ$, the other at $180-183^\circ$ and the mixture of the two melted at an intermediate point⁷⁾. These reports suggested that the structure (IV) was desirable for that of hexahydronezukone.

To confirm this, 4-isopropylcycloheptanone (IV), b.p. 66° at 3 mmHg, semicarbazone melting at 130-150° (mixture), was synthesized from 4-isopropylcyclohexanone by ring expansion with diazomethane⁸⁾. And by comparison (i.r., n.m.r. and t.l.c.) of this synthesized sample with hexahydronezukone, hexahydronezukone was identified as 4-isopropylcycloheptanone. These results leave no doubt that nezukone is 4-isopropyltropone (I).

So far, a number of tropone derivatives has been synthesized by many workers. Concerning isopropyltropones, only 2-isopropyltropone has been synthesized and characterized by Nozoe and his co-workers⁹⁾. But neither 3- nor 4-isopropyltropone has been characterized. This is the first case that tropones are isolated from natural resources. It is very interesting in view of biochemistry that 4-isopropyltropone was found together with carvacrol, α - and β -thujaplicins, (V) and (VI), in Nature.

REFERENCES

- 1) Y. Hirose and T. Nakatsuka, Mokuzai Gakkaishi 10, 253 (1964)
- 2) H. J. Dauben and H. J. Ringold, J. Amer. Chem. Soc. 73, 876 (1951)
- 3) T. Nozoe, T. Mukai, K. Takase and T. Nagase, Proc. Japan Acad. 28, 477 (1952)
- 4) W. von E. Doering and F. L. Detert, J. Amer. Chem. Soc. 73, 876 (1951)

- 5) L. J. Bellamy, The Infra-red Spectra of Complex Molecules
p. 147. John Wiley and Sons, INC., New York (1958)
- 6) S. Seto, Science Repts. Tōhoku Univ. 37, 286 (1953)
- 7) J. W. Cook, R. A. Raphael and A. I. Scott, J. Chem. Soc.
695 (1951)
- 8) T. Nozoe, S. Seto, K. Kikuchi, T. Mukai, S. Matsumoto and
M. Murase, Proc. Japan Acad. 26, No. 7, 43 (1950)
- 9) T. Nozoe, T. Mukai and T. Tezuka, Bull. Chem. Soc. Japan
34, 619 (1961)