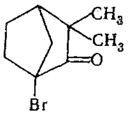
SYNTHESIS AND PROPERTIES OF 1-BROMO- AND 4-BROMOCAMPHENYLONES

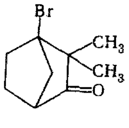
A. N. Nesmeyanov and I. I. Kritskaya

UDC 542.91 + 547.599.6

During 1950-1953, in connection with the problem of the steric factors of σ,π-conjugation [1, 2] studied by us at the time, we synthesized 1-bromocamphenylone (I) and its 4-bromo isomer (II).



(I)



(II)

The first compound has bromine in the α-position to the carbonyl group and in both compounds the bromine is found in the bridgehead. It was interesting to compare the exchange capacity of the two bromine atoms and to determine if the proximity of the carbonyl affects the replaceability of the bromine in the manner customary for an open chain, or whether the impossibility of Walden inversion in the rigid bicyclic system makes the halogen in both positions equally inert, and the proximity of the carbonyl is without effect. Experiment revealed that the latter of the alternatives is correct. The bromine in (I) is quite inert and its ability to be replaced is about equal to that of the bromine in the 4-isomer (II), and its exchange capacity is even less than that of the bromine in 1-bromobicyclo[1.2.2]heptane.

Both bromo ketones failed to react with Mg under the usual conditions, with Zn at 110-120°, or with Cu at 180-200°. (I) and (II) were recovered quantitatively from these experiments, with good melting points. Some activity toward the alkali metals was observed. With Li in heptane at the boil this activity was negligible and here (II) was recovered for the most part unchanged. With Na under the same conditions the reaction goes to the extent of 86 and 92% for (I) and (II) respectively, judging by the amount of Br^- formed. Carbonation of the reaction mixture occurred in these experiments, but we were unable to find either acids, or the camphenylone, or the products of a possible Wurtz reaction. As a result, it is difficult to say w whether the structure of the bicycle was retained during the cleavage of the halogen by the alkali metal. (I) and (II) failed to react with amines when heated for a long time at 100°, or with $AgNO_3$ in aqueous alcohol at 100°. However, under more drastic conditions, at 150° for 12 h, we obtained 5.2 and 5% of AgBr, respectively. This is approximately 1/20 of that obtained in the solvolysis of 1-bromobicyclo[1.2.2]heptane under comparable conditions [3]. We attribute this fact to the "compression effect" [1]. The presence of an exo-, or even more so of an endocyclic double bond in the quite rigid bicycloheptane system should increase the strain and the formation of the carbonium ion, requiring a planar configuration, becomes even more difficult in such a system.

EXPERIMENTAL

Synthesis of 1-Bromocamphenylone (I). (I) was obtained by treating the silver salt of camphenonic acid with bromine in anhydrous CCl_4 medium; yield 74%; m.p. 34-35° (from alcohol); b.p. 103-104° (3 mm). Found: C 50.42; 50.36; H 6.23; 6.30; Br 36.40; 36.28%. $C_9H_{13}BrO$. Calculated: C 49.78; H 6.03; Br 36.81%. The semicarbazone of (I) is formed very slowly, m.p. 211-212° (from acetone). It should be mentioned that the Ag salt of camphenonic acid, obtained by the exchange reaction of the Ba salt with $AgNO_3$, apparently has polymorphous modifications that differ in color and photochemical stability. One of them is white, and is exceedingly sensitive to light, rapidly changing to a yellow compound with decomposition point 226°. Found: Ag 37.75; 37.70%. The second modification is yellow, which is stable to light for an indefinite

---

Institute of Heteroorganic Compounds, Academy of Sciences of the USSR. Translated from Izvestiya Akademii Nauk SSSR, Seriya Khimicheskaya, No. 9, pp. 1652-1653, September, 1966. Original article submitted February 11, 1966.

length of time, changes its color to white at 170-175°, and decomposes at 226°. Found: Ag 37.49; 37.54%. $C_9H_{13}AgO_3$. Calculated: Ag 37.37%. The yellow salt gives well-shaped needle crystals that dissolve in $CHCl_3$ with the formation of a colorless solution.

Preparation of 4-Bromocamphenylone (II). (II) was obtained by the following series of steps: camphor → 2,2-dibromocamphane → 4-bromocamphene → 4-bromocamphenylone. The reaction of camphor with a mixture (1 : 1) of PBr_5 and PBr_3 at 20° for 6 days gave 2,2-dibromocamphane in approximately 88% yield. It is unstable, easily cleaves HBr, and could not be isolated in the pure state. The crude reaction product was heated with excess anhydrous CH_3COOK in phenol medium at 150-175° for 15 min, after which the mixture was treated with alkali and the obtained 4-bromocamphene was steam-distilled. It contained about 25 wt.% of the starting camphor, which was separated as the semicarbazone. The yield of 4-bromocamphene was based on the camphor was approximately 45%, m.p. 110-114°. Found: C 55.49; 55.42; H 7.06; 7.15; Br 37.39; 37.21%. $C_{10}H_{15}Br$. Calculated: C 55.86; H 6.98; Br 37.16%. Besides 4-bromocamphene, a mixture of liquid products was formed, which we were unable to identify.

The oxidation of 4-bromocamphene was accomplished with ozone in glacial acetic acid medium at ~ 20°. At the end of oxidation the mixture was diluted with water, and the obtained semiliquid reaction product was treated with semicarbazide in alcohol solution. After 48 h the liquid reaction products were steam-distilled, and the residual semicarbazone of (II) was filtered. Yield 36.5% when based on 4-bromocamphene; m.p. 218° (from alcohol). Found: C 43.73; 43.74; H 6.05; 5.94; Br 29.23; 29.31; N 15.77; 15.80%. $C_{10}H_{16}BrN_3O$. Calculated: C 43.79; H 5.88; Br 29.16; N 15.33%. The semicarbazone of (II) was then hydrolyzed with excess 20% H_2SO_4 solution by heating for 1.5 h, and the liberated (II) was steam-distilled; yield 54%; m.p. 166° (from alcohol). Found: C 49.87; 49.84; H 5.94; 5.93; Br 36.64; 36.84%. $C_9H_{13}BrO$. Calculated: C 49.78; H 6.03; Br 36.81%. Hydrazone, m.p. 105-106.5° (from a benzene — petroleum ether mixture). Found: C 46.78; 46.67; H 6.76; 6.70; Br 34.54; 34.45; N 12.27; 12.08%. $C_9H_{12}BrN_2$. Calculated: C 46.79; H 6.49; Br 34.51; N 12.13%.

Since the structure of 6-chlorocamphene was postulated for the chlorinated analog [4, 5], the position of the bromine in (II) was proved by the alkaline degradation of (II) to 3-isopropylidenecyclopentanecarboxylic acid (III). For this a mixture of the bromo ketone and alcoholic KOH in a molar ratio of 1 : 2 was heated for 5 h, after which dilution and acidification with dilute HNO_3 solution gave (III) in 92% yield, m.p. 51° (from aqueous alcohol). Found: C 69.44; 69.51; H 9.26; 9.14%. $C_9H_{14}O_2$. Calculated: C 70.09; H 9.14%. The amount of Br^- ion, determined as AgBr, was 98.5%. The position of the double bond in (III), and consequently, the position of the bromine in the bromo ketone, was proved by ozonolysis in $CHCl_3$ medium at ~ 20°, as a result of which we isolated cyclopentanone-3-carboxylic acid with m.p. 61-62°; semicarbazone, m.p. 189-190°. Found: C 45.49; 45.64; H 6.06; 6.04; N 22.34; 22.23%. $C_7H_{11}N_3O_3$. Calculated: C 45.39; H 5.98; N 22.69%;. Acetone was determined by the iodoform reaction to be present in the aqueous solution from the decomposition of the mixture; the iodoform had m.p. 119°.

CONCLUSIONS

1. The 1-bromo- and 4-bromocamphenylones were prepared.
2. In both compounds the bromine is equally unreactive.

LITERATURE CITED

1. A. N. Nesmeyanov and I. I. Kritskaya, Dokl. AN SSSR, 121, 477 (1958).
2. A. N. Nesmeyanov, Uch. Zap. MGU, No. 132, 1 (1950); Selected Works [in Russian], 3, Izd. AN SSSR, (1959), p. 571.
3. W. E. von Doering, M. Levitz, A. Sayigh, M. Sprecher, and W. P. Whelan, J. Am. Chem. Soc., 75, 1008 (1963).
4. H. Meerwein and R. Wortmann, Ann. Chem., 435, 190 (1923).
5. J. Houben and E. Pfankuch, Ann. Chem., 501, 219 (1933).