239. *A Resolution of Benzoin.*

By Archibald B. Crawford and Forsyth J. Wilson.

In continuation of previous work (Wilson and Crawford, J., 1925, **127**, 103) a resolution of *r*-benzoin (cf. Wilson and Hopper, J., 1928, 2483, for a resolution by a different method) has been accomplished by means of *l*-δ-menthylsemicarbazide (I), $NH_2·NH·CO·NH·C_{10}H_{19}$, the product, l-*benzoin*-l-δ-*menthylsemicarbazone* (II), $CHPh(OH)·CPh:N·NH·CO·NH·C_{10}H_{19}$, yielding *l*-benzoin on hydrolysis with acid.

In the preparation of (I) it now transpires that the intermediate acetone-*l*-δ-menthylsemicarbazone (III), $CMe_2:N·NH·CO·NH·C_{10}H_{19}$, is dimorphous. The form (prismatic needles, m. p. 128°) obtained in the first series of preparations (*loc. cit.*) has not been reproduced; as now obtained, the substance crystallises in rhombic prisms, m. p. 179·5—180°. Both forms show the same specific rotation in alcohol, have the same nitrogen content, and on hydrolysis give the same base (I), m. p. 138°. It has not been found possible to produce the form melting at 128° by seeding in various solvents; one specimen, melting originally at 128°, melted two years later at 179° without previous change; and others melted sharply or softened considerably at 128°, solidified again with expansion, and then melted sharply at 179°. The specific rotations of (I) and (III) are somewhat higher than those previously recorded, presumably owing to the use of a purer specimen of *l*-menthylamine.

The preparation of (I) from *l*-menthylcarbimide and hydrazine hydrate was attempted, but very little was obtained, the chief product being s.-l-*dimenthylcarbamylhydrazine* (IV), formed thus: $N_2H_4 + 2C_{10}H_{19}·NCO = C_{10}H_{19}·NH·CO·NH·NH·CO·NH·C_{10}H_{19}$. Acetone-hydrazone with *l*-menthylcarbimide gave (III) in poor yield, the main product being (IV).

In preparing semicarbazones from semicarbazide hydrochloride, it is customary to add potassium acetate, ostensibly to remove hydrochloric acid. In similar preparations of δ-substituted semicarbazones from the semicarbazides in this laboratory it became evident that not only was the potassium salt a buffering agent but that the acidity catalysed the reaction (confirmed quantitatively by Conant and Bartlett, *J. Amer. Chem. Soc.*, 1932, **54**, 2881); these condensations, therefore, were always carried out in presence of acetic acid. The condensation of *r*-benzoin with (I) is completed in five hours in boiling absolute alcohol when six to ten drops of glacial acetic acid are present; without the catalyst the reaction requires as many days. The only product obtained (II) crystallised but slowly from the gummy matrix in the presence of light petroleum; once obtained, it crystallised with ease from alcohol in well-formed octahedra, occasionally in coarser aggregates. The deposition of (II) from the gummy matrix has already occupied several years and is still proceeding; no attempt, therefore, has been made to examine the residue for the corresponding *d*-benzoin derivative.

In view of the ease of oxidation of benzoin to benzil derivatives in the presence of semicarbazide and acid (Hopper, J., 1925, **127**, 1282), the hydrolysis of (II) to *l*-benzoin by dilute aqueous-alcoholic sulphuric acid was carefully controlled; the method of Kon (J., 1930, 1616) was ineffective in this case. The *l*-benzoin so obtained was characterised by comparison with authentic specimens kindly supplied by Professor McKenzie and by Dr. H. G. Rule, to both of whom our best thanks are due, and by analysis. As a further check, *l*-benzoin was prepared from amygdalin by the method of Smith (*Ber.*, 1931, **64**, 427) and converted into *l*-benzoin-*l*-δ-menthylsemicarbazone, which agreed in properties, melting point, and rotation with (II) as obtained by the resolution. All the reactions were carried out in quartz apparatus.

It is proposed to use (II) and similar active semicarbazones for further polarimetric work connected with their intrinsic properties and rate of formation.

EXPERIMENTAL.

Acetone-l-δ-*menthylsemicarbazone* (III).—The *l*-menthylamine employed was prepared from *l*-menthol and gave $[\alpha]_D^{20^\circ}$ − 40·13°, a slightly higher value than that previously found (*loc. cit.*). The acetone-*l*-δ-menthylsemicarbazone obtained from this crystallised from alcohol in rhombic prisms, m. p. 179·5—180° (Found : N, 16·7. Calc. for $C_{14}H_{27}ON_3$: N, 16·6%). Polarimetric determinations ($l = 2$) in alcohol gave $\alpha_D^{13\cdot8^\circ}$ − 2·66° and $\alpha_D^{20^\circ}$ − 2·65° for $c = 2\cdot011$ and $\alpha_D^{15^\circ}$ − 5·28° for $c = 4\cdot023$; whence $[\alpha]_D^{13\cdot8^\circ} = -66\cdot15^\circ$, $[\alpha]_D^{20^\circ} = -65\cdot89^\circ$, and $[\alpha]_D^{15^\circ} = -65\cdot62^\circ$. In comparison, the form, m. p. 128°, gave ($l = 2$) in alcohol $\alpha_D^{20^\circ}$ − 2·61° ($c = 2\cdot009$), whence $[\alpha]_D^{20^\circ} = -64\cdot93^\circ$. *l*-δ-Menthylsemicarbazide (I) obtained from the above substance, sodium bicarbonate being used instead of sodium hydroxide to liberate the base from its hydrochloride (*loc. cit.*), gave for two separate preparations (alcohol, $l = 2$) $\alpha_D^{14^\circ}$ − 4·26° for $c = 2\cdot702$ and $\alpha_D^{20\cdot5^\circ}$ − 3·23° for $c = 2\cdot002$; whence $[\alpha]_D^{14^\circ} = -80\cdot69^\circ$ and $[\alpha]_D^{20\cdot5^\circ} = -80\cdot69^\circ$. Both (I) and (III) can be freed from any *s.*-*l*-dimenthylcarbamylhydrazine by their greater solubility in dioxan (cf. Hopper, *J. Roy. Tech. Coll.*, 1927, **1**, 48).

s.-l-*Dimenthylcarbamylhydrazine* (IV) was obtained in an attempt to prepare (I) by adding *l*-menthylcarbimide (Neville and Pickard, J., 1904, **85**, 688) dropwise and with cooling to hydrazine hydrate (1 mol.) in ether. It was the chief product, (I) being formed in only small amount; the separation of the two was effected by means of dioxan. The substance crystallised from alcohol or dioxan in cotton-like masses of needles, m. p. 240° (Found : N, 14·0. $C_{22}H_{42}O_2N_4$ requires N, 14·2%); $[\alpha]_D^{16^\circ}$ − 83·4° in alcohol ($l = 2$, $c = 3\cdot648$). Acetonehydrazone (Curtius and Pflug, *J. pr. Chem.*, 1891, **44**, 543), dry and containing no free hydrazine, when mixed with *l*-menthyl carbimide (1 mol.) gave, after 2 days, chiefly (IV) and a small amount of (III). For the preparation of the latter, the method is not satisfactory.

Resolution of r-*Benzoin.*—l-*Benzoin*-l-δ-*menthylsemicarbazone* (II). An absolute alcoholic solution of *r*-benzoin (16 g.) and *l*-δ-menthylsemicarbazide (16 g.) containing 10 drops of glacial acetic acid was refluxed on the water-bath for 5 hours. After removal of the solvent under reduced pressure, the residue was dissolved in light petroleum (b. p. 40—60°), from which crystals began to separate after several months, the deposition still proceeding after several years. Crystallising with ease from absolute alcohol, l-*benzoin*-l-δ-*menthylsemicarbazone* forms fine octahedra, m. p. 194—195°, slightly soluble in alcohol and light petroleum, very soluble in chloroform (Found : N, 10·2, 10·4. $C_{25}H_{33}O_2N_3$ requires N, 10·3%). In chloroform ($l = 2$) it gave $\alpha_D^{15\cdot5^\circ}$ − 7·49° ($c = 2\cdot259$), $[\alpha]_D^{15\cdot5^\circ}$ − 165·9°; $\alpha_D^{20^\circ}$ − 7·40° ($c = 2\cdot258$), $[\alpha]_D^{20^\circ}$ − 163·9°. As mentioned later, the same substance was prepared from an authentic specimen of *l*-benzoin. The specific rotation is very susceptible to temperature and concentration changes.

Hydrolysis of (II) *to* l-*benzoin.* To 0·5 g. of the substance, dissolved in 10 c.c. of alcohol, were added during 7 minutes 7·5 c.c. of 0·3*N*-sulphuric acid, alcohol being added from time to time to maintain solution on a boiling water-bath. After 10 minutes the solution was cooled and diluted with ice, and the white solid which separated was dissolved in hot light petroleum (b. p. 40—60°). At first, unchanged substance, then crops of impure *l*-benzoin were deposited. The aqueous liquor was extracted with carbon tetrachloride; the extract, after being shaken with an aqueous suspension of barium carbonate, yielded on evaporation a further quantity of *l*-benzoin. The residual aqueous solution from the hydrolysis was gently heated with barium carbonate and filtered; concentration then yielded *l*-δ-menthylsemicarbazide. In all, 1·5 g. of (II) were hydrolysed; the pure *l*-benzoin (m. p. 133—134°) after recrystallisation from alcohol amounted to 0·66 g. (84·5% yield). It showed no depression of melting point after admixture with two different authentic specimens [Found (micro) : C, 79·0, 79·2; H, 5·7, 5·7. Calc. for $C_{14}H_{12}O_2$ C, 79·3; H, 5·7%]. In acetone ($l = 4$) it gave $\alpha_D^{13·5°}$ — 5·06° ($c = 1·069$), $[\alpha]_D^{13·5°}$ — 118·3° (Hopper and Wilson, *loc. cit.*, gave $[\alpha]_D^{11°}$ — 118·5°). *l*-Benzoin prepared by the method of Smith (*loc. cit.*) (yield, 27% of purified substance, m. p. 134—135°, calculated on amygdalin) gave in acetone ($l = 2$) $\alpha_D^{15°}$ — 5·80° ($c = 2·451$), $[\alpha]_D^{15°}$ — 118·3°. It was converted as above into *l*-benzoin-*l*-δ-menthylsemicarbazone identical in melting point (194—195°) and rotation with our preparation; in chloroform ($l = 2$) $\alpha_D^{20°}$ — 7·43° ($c = 2·258$), $[\alpha]_D^{20°}$ — 164·5°.

We wish to thank Imperial Chemical Industries Ltd. for grants.

THE ROYAL TECHNICAL COLLEGE, GLASGOW. [*Received, June 7th*, 1934.]