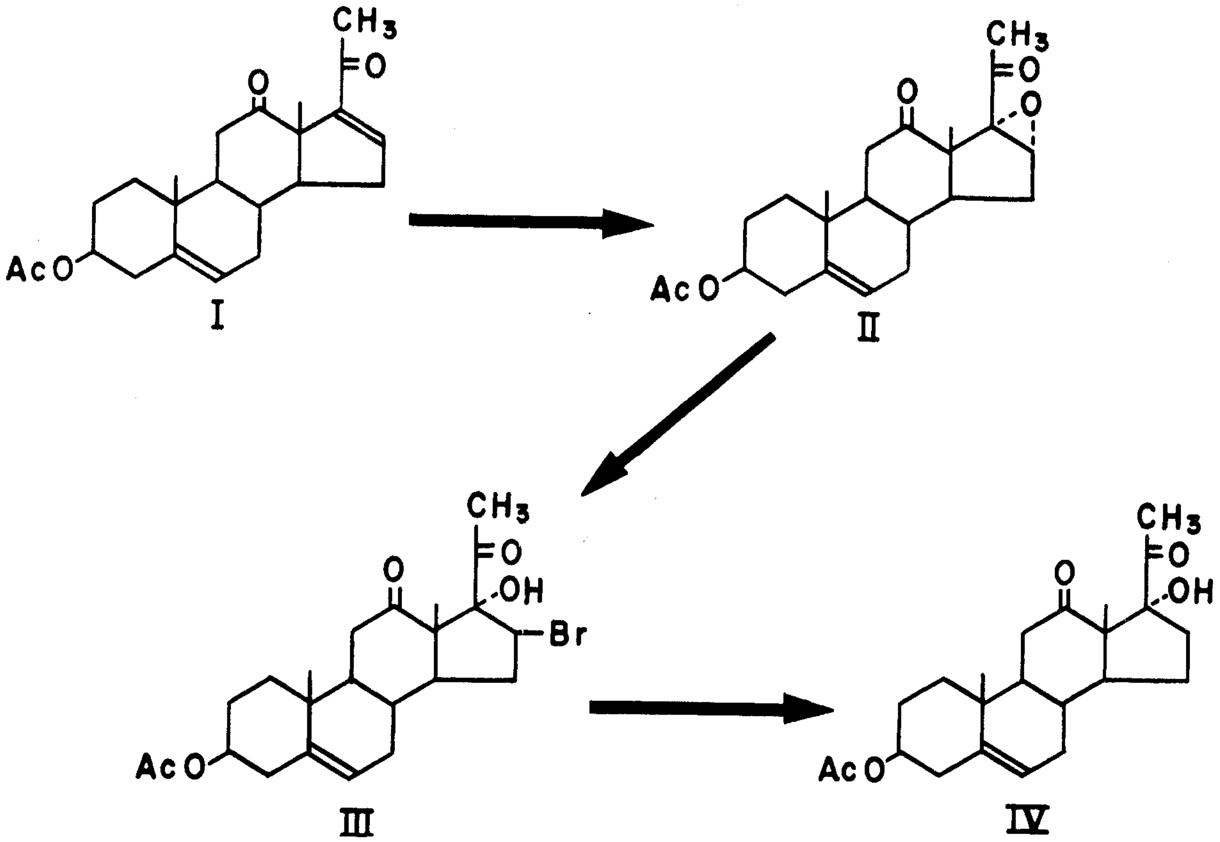

was refluxed 4 hr. with 48 g. of a Raney nickel catalyst. The catalyst was prepared from the alloy using Adkins' directions[7] modified by the acetone inactivation method of Barkley, *et al.*[8] The catalyst was filtered off and the solvents were evaporated. Trituration of the residue with ether gave 4 g. of dense granular polyhedra melting at about 170°, yield 83%. Recrystallization from cyclohexane (dense, granular crystal forms) and from methanol gave needles m.p. 181.0–182.2° with incomplete transition to plates, $[\alpha]^{25}_{D}$ −23.3°. The carbonyl infrared spectrum strongly resembled that of the hecogenin analog, Figure 1-B in reference 5, showing strong bands at 1735, 1706, and 1694 cm.$^{-1}$.

Anal. Calcd. for $C_{23}H_{32}O_5$: C, 71.10; H, 8.30. Found: C, 71.06; H, 8.31. An experiment using highly purified, isolated bromohydrin and a portion of the same Raney nickel catalyst used in the above experiment gave reversion of the bromohydrin to the epoxide.

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(9) A laboratory of the Eastern Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

A Note on the Preparation of β-Ionone

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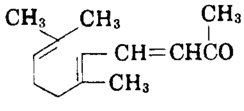
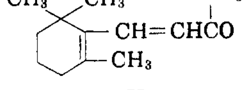
Since 1947, when the first technically feasible synthesis of vitamin A was announced,[1] the preparation of pure β-ionone has assumed considerable importance, as it forms one of the important intermediates in the above synthesis.

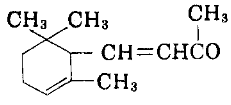
β-Ionone (II) is obtained along with the α-isomer (III) by the cyclization of pseudoionone (I) under the influence of acidic reagents.[2,3,4]



Pseudoionone (I)



β-ionone (II)



α-ionone (III)

The relative proportions of the two compounds

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(1) O. Isler and coworkers, *Helv. Chim. Acta*, **30**, 1911 (1947).

(2) Haarman and Reimer, German Patent 133,563, July 22, 1902.

(3) F. Tiemann, *Ber.*, **31**, 808, 867, 1736, 2313 (1898); **32**, 327 (1899); **33**, 3708 (1900).

(4) F. Tiemann and P. Krüger, *Ber.*, **26**, 2692 (1893).

obtained depend on the cyclizing agent used. The two have to be separated by a time-consuming method which depends on the difference in the solubilities of the bisulfite compounds of the two in water in the presence of sodium chloride.[5]

It was, therefore, thought that a method which would give predominantly β-ionone as compared to the yield of its isomer, α-ionone, would be of great interest for the manufacture of Vitamin A. Such a method would make it unnecessary to use the above method of separation.

The relative proportions of the α- and β-isomers obtained on cyclization of pseudoionone are dependent on the cyclizing agent employed, sulfuric acid giving mainly β-ionone and phosphoric, fumaric and other weaker acids[7] giving mainly the α-isomer. E. E. Royals[8] investigated the several procedures and suggested the use of a mixture of 70 parts of conc. sulphuric acid and 30 parts of glacial acetic acid as the cyclizing agent for the preparation of β-ionone. He claimed, on the basis of a comparison of the refractive index of the final product with that of pure β-ionone obtained by other methods, to have obtained β-ionine (90% purity) in good yield (71% on the basis of the weight of pseudoionone used).

During the course of the present work, it was found that, though the above cyclizing agent could be used for the preparation of pure β-ionone, the procedure adopted by E. E. Royals leads to unsatisfactory results. This was not noticed earlier due to the fact that the refractive index alone was used to evaluate the purity of the β-ionone obtained. It was found that the u.v. absorption spectrum (the measurement of the molecular extinction coefficient at 296 mμ) had also to be employed to verify the same.[9] When the purity of the cyclized product obtained by the procedure of Royals was measured by both the methods, it was found to contain only 50% of β-ionone. This was supported by the preparation of the bisulphite addition product of the ionone when only 50% of the cyclized product went into solution. (The u.v. absorption spectrum of the insoluble part was found not to correspond to that of α-ionone either.)

Y. R. Naves and coworkers[10] have reinvestigated the yields of the products obtained by the cyclization of pseudoionone by the use of several cyclizing agents proposed by Royals, other than the one investigated by us. By means of analytical methods, especially analysis in the infrared region between 12 and 14 microns, they have obtained results which also indicate the unreliability of conclusions based on the measurement of the refractive index of the cyclized product alone.

After a series of experiments, it was found that the yields claimed by Royals[8] could be obtained by modifying his procedure in two ways. (a) The temperature of the reaction mass after cyclization is not allowed to rise to 25°C as given by him but is kept till the end below 15°C. (b) The product of the reaction is poured into a mixture of broken ice and ether with rapid stirring and not into ice water alone without mechanical stirring as suggested in the earlier work. The presence of ether during decomposition facilitates the immediate taking up of the β-ionone formed without allowing it to remain in contact with acid.

The results obtained by us in this way support the theory put forward by E. Royals as to the influence of the strength of the acid on the cyclization of pseudoionone.

EXPERIMENTAL

The pseudoionone used in this experiment was prepared from lemongrass oil (with 75% citral content) by condensation with acetone in the presence of aqueous sodium hydroxide.[6] The steam volatile impurities were removed by steam distillation[8] and the fraction showing n_D^{20} of 1.5230–1.5280 (b.p. 90–100°/0.2 mm.) was taken for use as pseudoionone.

The sulfuric acid and the glacial acetic acid used in these experiments were of the C.P. quality. The concentration of sulphuric acid was checked by density measurements (95% concentration).

Cyclization of pseudoionone to β-ionone. The cyclizing agent [175 g. of conc. H_2SO_4 (95%) and 75 g. of glacial acetic acid] was placed in a 500 ml. three-necked flask with a mechanical stirrer, a dropping funnel, and a thermometer reaching into the reaction mixture. The flask was cooled in an ice bath and the cyclizing agent was vigorously stirred while pseudoionone (50 g.) was added dropwise during 30-45 min.; the rate of addition was adjusted so that the temperature of the reaction mixture did not exceed 10–15°C. When the pseudoionone had all been added, the cooling bath was removed and the stirring continued at 10–15°C. for 5–10 min. The reaction mixture was poured into a mixture of ice water (1 l.) and ether (200–250 ml.) with vigorous stirring. The water layer was again extracted with ether and the combined ether extracts were washed with water, sodium carbonate solution (1%), then to neutral with water and dried over anhydrous sodium sulphate. After the removal of ether from the extracts by distillation, the residue was steam distilled and the ionone passed over in the distillate. The distillate was extracted with ether, the ether extract was dried over anhydrous sodium sulphate and then the ether was removed by distillation. The residue was distilled under reduced pressure from a 250 cc. Claisen flask through an 8 in. column filled with Nichrome rings. β-Ionone (37 g.) was obtained as a pleasant smelling light yellow colored liquid b.p. 105–108°/0.22 m.; n_D^{28} 1.5170; ϵ_{max} (296 mμ) 9500 (in 95% ethanol) corresponding to a β-ionone content of 90%.

The β-ionone obtained by the procedure of Royals was found to give a value in many cases of n_D^{28} 1.5150 but of ϵ_{max} (296 mμ); 5000 corresponding to a β-ionone content of 50%.

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Some Aromatic and Heterocyclic Derivatives of Carbazole[1]

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The simplest N-arylcarbazole, 9-phenylcarbazole, was first mentioned in a German patent[2] as having been obtained in unspecified yield by heating potassium carbazole, bromobenzene, and copper powder in an autoclave at 180–200°. Dunlop and Tucker[3] obtained a 65% yield of the compound by heating carbazole, iodobenzene, potassium carbonate, and copper bronze at 190–200°. The same substances refluxed in nitrobenzene resulted in an 88% yield of 9-phenylcarbazole.[4] Lister[5] states that in Hager's method bromobenzene could be substituted for iodobenzene, and that the nitrobenzene could be replaced by high-boiling petroleum ether. Although the yield drops to between 50 and 60%, the use of petroleum ether is said to facilitate separation of the product from unreacted carbazole as the latter is soluble only with difficulty in the petroleum ether. Other syntheses of 9-phenylcarbazole involve the thermal decarboxylation of 9-*o*-carboxyphenylcarbazole,[6] and the dehydration of 9-phenyltetrahydrocarbazole with chloranil.[7]

Although substituents, as nitro[3,8] and carboxyl,[6,9] have been introduced on the phenyl group, no other aromatic systems have been attached to the 9-position of carbazole. We now wish to report the preparation of 9-*p*-biphenylyl-, 9-2′-pyridyl-, and 9-2′-quinolylcarbazole, as well as 4,4′-*bis*-(9-carbazolyl)-biphenyl and *p*-*bis*-(9-carbazolyl)-benzene. So far attempts to prepare 9-(*p*-dimethylaminophenyl)-carbazole in various solvents, or without a solvent, have been unsuccessful.

Since 2- and 4-halopyridines and quinolines are more reactive than benzenoid halides, attempts were made to synthesize 9-2′-pyridyl- and 9-2′-quinolylcarbazole under less strenuous conditions. 9-Alkylcarbazoles can easily be prepared by refluxing alkyl iodides and carbazole in acetone solution in the presence of potassium hydroxide.[10] We found that neither 2-bromo- nor 2-chloropyridine yielded the desired product by this method. Higher reaction temperatures, obtained by using pyridine as a solvent, likewise failed to give N-substituted carbazoles either with or without added potassium hydroxide. A report by Banks[11] indicates that the amination of certain haloheterocycles may be acid-catalyzed.

The compounds described at this time were prepared incidental to a study concerned with organic liquid solution scintillators. Evaluation of the compounds for this purpose is being made by Dr. Wright H. Langham, F. N. Hayes, and D. G. Ott of the Los Alamos Laboratories who will report the results later.

EXPERIMENTAL[12]

9-p-Biphenylylcarbazole. In a 1-l., 3-necked flask equipped with a thermometer, mechanical stirrer, and a moisture trap with attached air condenser, a mixture of 16.7 g. (0.1 mole) of carbazole, 23.3 g. (0.1 mole) of *p*-bromobiphenyl, 13.8 g. (0.1 mole) of anhydrous potassium carbonate, 0.2 g. of copper bronze, and 250 ml. of petroleum ether (b.p. 190–210°) was stirred and refluxed for 12 hr. The solvent was removed by steam distillation and the residue extracted with two 100-ml. portions of hot benzene and two 50-ml. portions. The benzene was evaporated to yield a yellowish brown solid which was dissolved in 300 ml. of a 2:1 mixture of benzene-petroleum ether (b.p. 60–70°) then chromatographed on alumina using 1:1 benzene-petroleum ether (b.p. 60–70°) as eluant. The largest fraction (m.p. 81-165°) was extracted with ethanol to remove any *p*-bromobiphenyl and the residue recrystallized from a mixture of petroleum ether (b.p. 60–70°) and benzene to yield 3.1 g. (10%) of colorless 9-*p*-biphenylylcarbazole, melting at 224–226°. The infrared spectrum indicated both *o*- and *p*-disubstitution, and no N—H band.

Anal. Calcd. for $C_{24}H_{17}N$: N, 4.39. Found: N, 4.24, 4.23.

p-Bis-(9-carbazoyl)-benzene. Refluxing a mixture of 10 g. (0.0598 mole) of carbazole, 8.3 g. (0.025 mole) of *p*-diiodobenzene, 13.8 g. (0.1 mole) of anhydrous potassium carbonate, 1.0 g. of copper bronze, and 200 ml. of petroleum ether (b.p. 190–210°) for 24 hr., steam distilling the product, and extracting the residue with hot benzene gave a dark solution which was treated with Norit-A and cooled to give 4.0 g. (39%) of white product, m.p. 320–322°. Subsequent recrystallization did not raise the melting point. Evaporation of the mother liquor gave a dark solid which was washed with hot ethanol, and then recrystallized from benzene-petroleum ether (b.p. 60–70°) to yield an additional 1.5 g. (15%) of product, m.p. 319–321°.

Anal. Calcd. for $C_{30}H_{20}N_2$: C, 88.20; H, 4.94. Found: C, 88.51, 88.44; H, 4.74, 4.83.

4,4′-Bis-(9-carbazolyl)-biphenyl. In an apparatus similar to that described above, but without a moisture trap, a mixture of 18.4 g. (0.11 mole) of carbazole, 15.6 g. (0.05 mole) of 4,4′-dibromobiphenyl, 15.2 g. (0.11 mole) of potas-

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[1] This work was supported by the United States Atomic Energy Commission under Contract No. AT(11-1)-59.

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[12] All melting points are uncorrected.