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THE REACTIONS OF 5-METHOXY-3-PHENYL AND 5-METHOXY-3-BENZYLHYDANTOINS WITH CONJUGATED DIENES.

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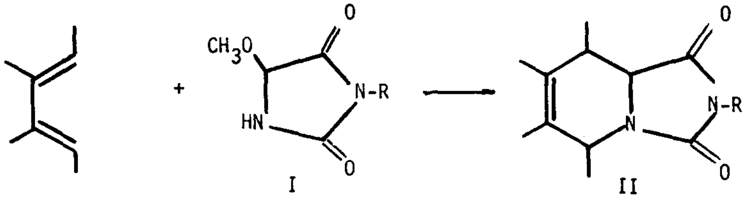
4-Phenyl-1,2,4-triazoline-3,5-dione is one of the most reactive dienophiles (1), it is more reactive than its carbon analog, N-phenylmaleimide. In an attempt to prepare the intermediate dienophile, 2,5-imidazolinedione, which contains a carbon-nitrogen double bond, we succeeded in obtaining only its methanol addition product (I, R=Ø). This 5-methoxyhydantoin did, however, react thermally, or in the presence of an acid catalyst, with various conjugated dienes to give Diels-Alder type adducts (II) or amidoalkylation products (2,3) (e.g. VIII, X):

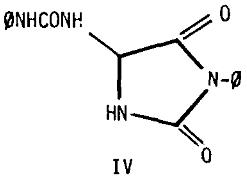


I II

The 5-methoxy-3-phenylhydantoin (I, R=Ø; m.p. 109^{o}) was prepared by the cyclization of the bisadduct III and subsequent treatment of the ureidohydantoin (IV, m.p. 251^{o}) with hydrogen bromide in acetic acid, followed by methanol:

$$\text{Ø}NHCONH_2 + OCHCO_2C_4H_9 \xrightarrow{H^+} (\text{Ø}NHCONH)_2CHCO_2C_4H_9 \longrightarrow$$

III



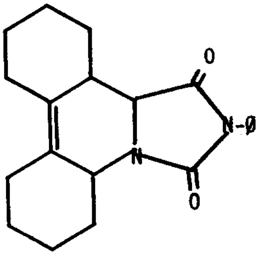
IV

The methoxyhydantoin, which was obtained in 43% overall yield, showed a characteristic hydantoin infrared spectrum, two CO absorptions at 1790 and 1725 cm^{-1} and an NH absorption at 3440 cm^{-1}. Its n.m.r. spectrum showed singlets at δ3.45 (3H) and δ7.42 (5H), and doublets at δ5.17 (1H, J=2 cps) and δ7.25 (1H).

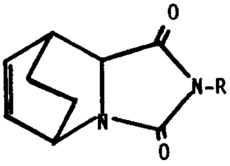
Reacting 1,1'-bicyclopentenyl, bicyclohexenyl and bicycloheptenyl with 5-methoxy-3-phenylhydantoin in boiling benzene and in the presence of trifluoroacetic acid for 16 hr. afforded crystalline products in 60-70% yields. Two isomers were separated in each case and were found to be, according to their infrared and n.m.r. spectra, Diels-Alder type adducts (e.g. V). They retained the hydantoin CO absorptions but lacked the NH absorption at 3400 - 3500 cm^{-1} in the infrared. The n.m.r. spectra showed absorptions at δ3.5-4.5, which are typical of methine groups α to a carbonyl and α to an amidic nitrogen, or allylic protons which are also α to an amidic nitrogen. The two bicyclopentenyl isomeric adducts melted at 130° and 135°, the bicyclohexenyl isomers melted at 131 and 173°, and the bicycloheptenyl derivatives melted at 152° and 160°.

1,2,3,4-Tetramethylbutadiene and 3,4-diethyl-2,4-hexadiene reacted with the methoxyhydantoin (I, R=Ø) in boiling benzene and in the presence of naphthalenesulfonic acid within 2 hr. to give a single Diels-Alder type product in each case in 74% (m.p. 104°) and 70% (m.p. 95°) yield respectively. 1,3-Cyclohexadiene gave under similar experimental conditions the adduct VI (R=Ø) in 35% yield (m.p. 145°). This product is probably the endo isomer, since catalytic hydrogenation of the double bond caused a deshielding effect on the phenyl group in the n.m.r. (6 cps). Butadiene reacted with the methoxyhydantoin in benzene solution at room temperature and in the presence of boron trifluoride, to give two different products. The normal product (II) was obtained only in 10% yield (m.p. 152°). The main product of the reaction was compound VII (m.p. 110°; 50%). The solvent (benzene) participated in the amidoalkylation reaction. Under the same experimental conditions furan gave only the alkylation product VIII (m.p. 128°).

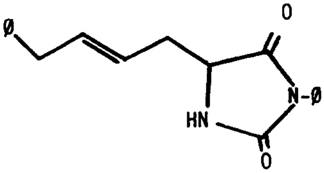
5-Methoxy-3-benzylhydantoin (3) (I, R=ØCH_2) reacted with the tetramethylbutadiene and cyclohexadiene in the presence of an acid catalyst to give crystalline Diels-Alder type products in 70% (m.p. 105°) and 28% (VI, R=ØCH_2; m.p. 125°) yield respectively. It also reacted with 1,4-diphenylbutadiene in boiling benzene and in the presence of trifluoroacetic acid to give a mixture of two Diels-Alder type adducts, which melted at 132° and 146°, and



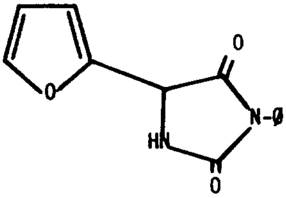
V



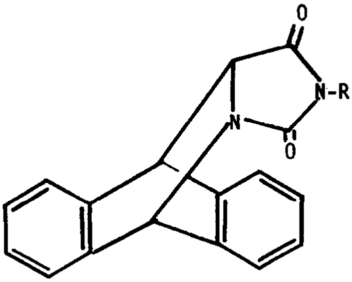
VI



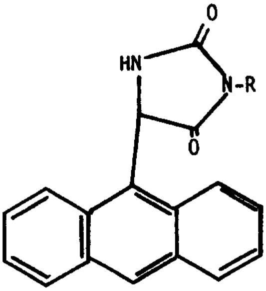
VII



VIII



IX



X

one alkylation product (m.p. 146°).

Anthracene afforded normal Diels-Alder products (IX) in 70-80% yield when treated with the methoxyhydantoins in boiling xylene for 72 hr. The normal product (IX, R=ϕCH_2; m.p. 231°) was further converted on treatment with naphthalenesulfonic acid in boiling benzene to the amidoalkylation product X (R=ϕCH_2). The latter was also obtained in the direct condensation of anthracene with the dienophile in boiling benzene and in the presence of the sulfonic acid (m.p. 240°).

1,1'-Bicyclohexenyl and 1,2,3,4-tetramethylbutadiene reacted thermally with the methoxyhydantoins (boiling xylene) to give the same products that were obtained in the acid catalyzed reaction. All the new compounds described above had satisfactory analyses and showed characteristic infrared, n.m.r. and mass spectra.

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