Unusual Thermal Rearrangement of the *endo*-Peroxides of 2,5-Dimethylfurans

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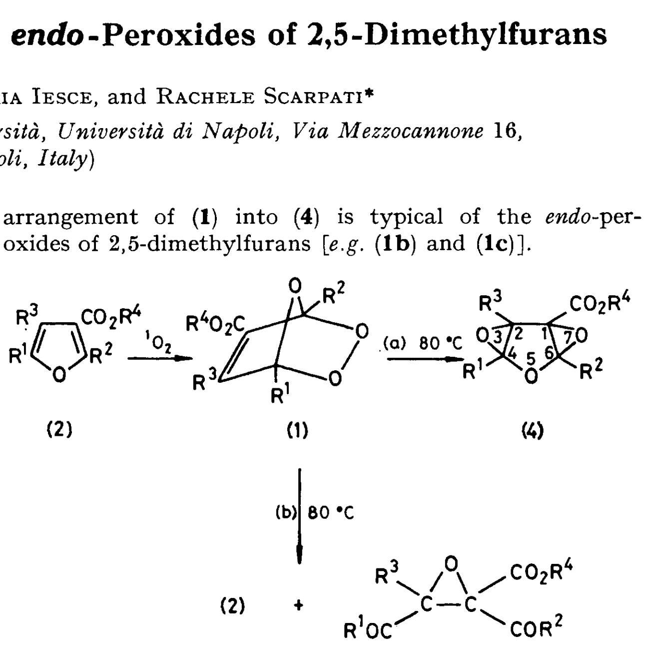
Summary Thermal rearrangement of the *endo*-peroxides of the 2,5-dimethylfurans (**1b**) and (**1c**) in refluxing benzene leads to the corresponding diepoxides (**4b**) and (**4c**), which provides a convenient entry to the synthesis of these compounds which are structurally related to crotepoxide.

Recently, we reported that the *endo*-peroxide (**1a**), which is stable at −15 °C,[1] when refluxed in benzene yielded mainly the furan (**2a**) and the epoxypropionate (**3a**), along with polymeric material.[2]

We have now found that dimethyl 1,4-dimethyl-2,3,7-trioxabicyclo[2.2.1]hept-5-ene-5,6-dicarboxylate (**1b**),† prepared in quantitative yield by the dye-sensitized photooxidation of the furan (**2b**), was, when refluxed in benzene, quantitatively converted within 1·3 h into dimethyl 4,6-dimethyl-3,5,7-trioxatricyclo[4.1.0.0^{2,4}]heptane-1,2-dicarboxylate (**4b**).‡ Under the same conditions the *endo*-peroxide of the 2,5-dimethylfuran (**1c**)[1] rearranged similarly to give, within 20 min, the diepoxide (**4c**)§ in quantitative yield, whereas the 2,5-diphenyl analogue (**1d**)† behaved as (**1a**) and yielded mainly the furan (**2d**) and the epoxypropionate (**3d**); the diepoxide (**4d**) was not detected. Thus, it seems that under the aforementioned conditions the rearrangement of (**1**) into (**4**) is typical of the *endo*-peroxides of 2,5-dimethylfurans [*e.g.* (**1b**) and (**1c**)].



a; R^1 = Ph, R^2 = R^4 = Me, R^3 = H
b; R^1 = R^2 = R^4 = Me, R^3 = CO$_2$Me
c; R^1 = R^2 = R^4 = Me, R^3 = H
d; R^1 = R^2 = Ph, R^3 = H, R^4 = Et

Scheme. (a). Compounds with R^1 = R^2 = Me; (b) compounds with R^1 and/or R^2 $\neq$ Me.

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† All new *endo*-peroxides gave the expected spectral (i.r. and ^{1}H and ^{13}C n.m.r.) and analytical (active oxygen) data.

‡ Liquid; ν (CCl$_4$) 1745 (CO$_2$Me) and 1100—1050 cm^{-1} (C–O–C); ^{1}H n.m.r. δ (C$_6$D$_6$) 1·47 (s, 6 H, 2 × Me) and 3·26 (s, 6 H, 2 × OMe); ^{13}C n.m.r. δ (CDCl$_3$) 15·0 (q, 2 × Me), 52·9 (q, 2 × OMe), 62·4 (s, C-1 and C-2), 98·2 (s, C-4 and C-6), and 164·2 (s, 2 × C=O); satisfactory elemental analyses were obtained.

§ Liquid; ν (CCl$_4$) 1740 (CO$_2$Me) and 1100—1050 cm^{-1} (C–O–C); ^{1}H n.m.r. δ (C$_6$D$_6$) 1·27 (s, 3 H, 4-Me), 1·43 (s, 3 H, 6-Me), 3·19 (s, 3 H, OMe), and 3·75 (s, 1 H, CH); ^{13}C n.m.r. δ (C$_6$D$_6$) 14·5 and 16·4 (2 × q, 2 × Me), 51·9 (q, OMe), 56·0 (d, CH), 67·1 (s, C-1), 91·8 and 96·4 (s, C-4 and C-6), and 173·8 (s, C=O).

The high yields together with the mild reaction conditions make the conversion of furans into diepoxides *via endo*-peroxides a synthetically useful route for tricyclic systems of the type (**4b**) and (**4c**), which represent the first examples of alkyl-substituted derivatives of the series.

It is noteworthy that compounds (**4**) are related structurally to the 1,3-diepoxide crotepoxide which is known to possess significant inhibitory activity against Lewis lung carcinoma and Walker intramuscular carcinoma.[3]

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