Antioxidant Properties of Benzimidazoles

5-Hydroxybenzimidazoles have been shown to possess marked antioxidant properties. By contrast benzimidazole and its 2-alkyl derivatives have no direct antioxidant activity, but appear to function as retarders of metal-catalyzed autoxidations.

As part of a study of oxidation of heterocyclic molecules related to their biological properties, oxidations of some benzimidazoles have been examined (Cole *et al.*, 1974). Relevant to this work the ability of these compounds to function as antioxidants has been evaluated, leading to the discovery of a novel class of active antioxidants.

EXPERIMENTAL SECTION

Benzimidazole and its 2-alkyl derivatives were prepared by standard methods (Phillips, 1928); 5-hydroxybenzimidazoles were formed by Udenfriend oxidation of the parent compounds (Udenfriend *et al.*, 1954). All compounds were shown to be pure by thin-layer chromatographic (tlc) analysis (Cole *et al.*, 1973). Squalene, vacuum distilled and filtered through grade I alumina under an atmosphere of nitrogen, was used as the substrate, for accelerated oxidations (in triplicate) at 60° under 1 atm pressure of oxygen.

RESULTS AND DISCUSSION

Results are expressed on the basis of time required to reach the arbitrary end point. Oxygen uptake (1% w/w) is shown in Table I.

It will be seen that benzimidazole itself and the 2-alkyl derivatives, while showing no direct antioxidant activity, nevertheless function as retarders of metal-catalyzed autoxidations. On the other hand, 5-hydroxybenzimidazole and 5-hydroxy-2-methylbenzimidazole function effectively as antioxidants.

A possible threefold action for benzimidazoles was envisaged. Thus, apart from direct action, metal scavenging, by complex formation (Goodgame and Cotton, 1962), was expected to counteract heavy metal catalysis of autoxidation. In addition, since chemical hydroxylation of benzimidazoles is known to produce 5-hydroxybenzimidazoles, the possible *in situ* formation of these molecules, leading to more effective antioxidants, was considered.

Present results show no direct antioxidant activity for the benzimidazoles, but demonstrate the expected effective properties of the 5-hydroxy derivatives. Although the metal scavenging effect leads to an observable but weak inhibition of autoxidation, the *in situ* hydroxylation process must be ruled out under the experimental conditions used.

Table I. Antioxidant Activity of Benzimidazoles

Addition[a]	Time to 1% w/v O uptake at 60°, min	Retardation factor[b]
None	135	
Benzimidazole	150	
2-Methyl-	148	
2-Ethyl-	140	
2-Nonyl-	140	
Cobalt stearate	39	
Cobalt stearate + benzimidazole	70	1.8[c]
Cobalt benzimidazole complex	86	2.2[c]
5-Hydroxybenzimidazole (0.025%)	12 hr	5.3
	34 hr	16.6
2-Methyl-	52 hr	23.1

[a] Concentration 0.1% unless otherwise stated. [b] Expressed as ratio of time required with the additive over time required for the control. [c] Relative to the simple cobalt-catalyzed autoxidation.

LITERATURE CITED

Cole, E. R., Crank, G., Salam-Sheikh, A., *J. Chromatogr.* **78**, 323 (1973).
Cole, E. R., Crank, G., Salam-Sheikh, A., manuscript in preparation (1974).
Goodgame, M., Cotton, F. A., *J. Amer. Chem. Soc.* **84**, 1543 (1962).
Phillips, M. A., *J. Chem. Soc.* **172**, 2393 (1928).
Udenfriend, S., Clark, C. T., Axelrod, J., Brodie, B. B., *J. Biol. Chem.* **208**, 731 (1954).

Edward R. Cole*
George Crank
Abdus Salam-Sheikh

Department of Applied Organic Chemistry
The University of New South Wales
Kensington, New South Wales, 2033, Australia

Received for review March 4, 1974. Accepted May 3, 1974.

Tentative Identification of Gibberellin A_7 in Immature Seeds of Iris

Four gibberellin-like substances were isolated from iris seeds. The least polar of these was tentatively identified as gibberellin A_7, based on chromatographic and fluorescence characteristics. Some properties of the other three are described.

Gibberellin-like activity has previously been detected in Wedgwood iris bulbs by Rodrigues-Pereira (1964). This has been confirmed by Aung *et al.* (1969). No attempt has previously been reported, however, to identify or to characterize the gibberellins involved. This paper reports the isolation and tentative identification of gibberellin A_7 and the presence of three additional polar gibberellin-like substances in iris seeds.