Synthesis of the Insect Dyestuff Kermesic Acid and Related Anthraquinones

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Summary The structurally related anthraquinones kermesic acid, laccaic acid D, and aloesaponarin-I and -II have been synthesised efficiently, key steps involving Diels–Alder additions and addition of 1,1-dimethoxyethene.

THIS communication reports syntheses of some natural anthraquinones incorporating the carbon-substituent pattern typified by kermesic acid (**1**). Such compounds, which include the ancient insect dyestuffs,[1] generally do not lend themselves to synthesis by conventional procedures.[2]

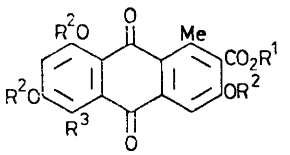
Diels–Alder addition of the diene (**2**) to 2,6-dichloro-1,4-benzoquinone in benzene gave the naphthoquinone (**3**) (80%) after thermal aromatization of the intermediate adduct. The diene system (**2**), a mixture of isomers, was obtained efficiently by treatment of ethyl 2-(1-methoxyethylidene)-3-oxobutanoate[3] with *NO*-bistrimethylsilylacetamide in ether.

The n.m.r. spectrum ($CDCl_3$) of compound (**3**), m.p. 174—175 °C, contained singlet benzenoid and quinonoid resonances at δ 7·54 and 7·16 along with signals characteristic of an ethyl and two methyl groups. Its formation involved regiospecific addition, the more nucleophilic terminus of the diene system attacking an unsubstituted quinonoid carbon. This is consistent with the behaviour of nucleophilic dienes towards chloro-quinones.[4] The isomeric quinone (**4**), m.p. 146—148 °C, was equally specifically obtained by reaction between (**2**) and 2,5-dichloro-1,4-benzoquinone.

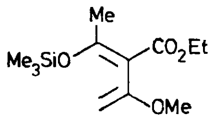
1 : 2-Addition of 1,1-dimethoxyethene to the naphthoquinone (**3**) in *NN*-dimethylformamide gave the anthraquinone (**5**) (65%), the direction of addition once again being controlled by the disposition of the halogeno-substituent.[5,6] The n.m.r. spectrum of the product, m.p. 189·5—190·5 °C, contained a singlet benzenoid resonance at δ 7·61 and *meta*-coupled doublets at δ 6·75 and 7·31. Conventional bromination[7] followed by displacement with sodium methoxide in methanol[8] gave the pentamethoxy-anthraquinone (**6**),[9] with singlet benzenoid resonances at δ 6·77 and 7·52. Dealkylation in an aluminium chloride–sodium chloride melt then gave kermesic acid (**1**),[9] identical with natural material. It was obtained in overall yield of 25% from 2,6-dichloro-1,4-benzoquinone.

Dealkylation of (**5**) gave the lac pigment laccaic acid D (**7**),[10] identical with material obtained from the reduction of kermesic acid.[9] Treatment with methanol–boron trifluoride gave the methyl ester (**8**), itself a natural product.[11]

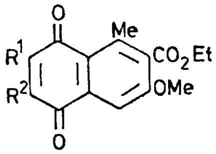
Addition of the diene system (**2**) to 3-chloro-5-hydroxy-1,4-naphthoquinone[12] proceeded as in the benzoquinone series to give the anthraquinone (**9**) (69%). Dealkylation to the acid (**10**) followed by conversion into the methyl ester as above gave the plant product aloesaponarin-I (**11**). Decarboxylation of (**10**) in boiling *NN*-diethylaniline gave aloesaponarin-II (**12**). Compounds (**11**) and (**12**) were each identical with authentic material.[11]



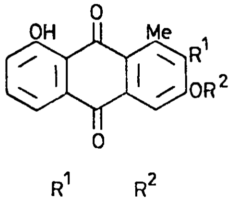
	R¹	R²	R³
(**1**);	H	H	OH
(**5**);	Et	Me	H
(**6**);	Me	Me	OMe
(**7**);	H	H	H
(**8**);	Me	H	H



(**2**)



	R¹	R²
(**3**);	Cl	H
(**4**);	H	Cl



	R¹	R²
(**9**);	CO_2Et	Me
(**10**);	CO_2H	H
(**11**);	CO_2Me	H
(**12**);	H	H

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