MAIN COMPONENTS IN *CEREUS PERUVIANUS* EPICUTICULAR WAX

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ABSTRACT.—The epicuticular wax of *Cereus peruvianus* (L.) Miller was analyzed. The main fractions are hydrocarbons (with C_{31} predominating) and esters.

Cactaceae, a botanical family original to the New World, is particularly well adapted to arid climates (1). Photosynthesis in cacti, which follows the CAM pathway (2), can proceed at internal temperatures 15° above the ambient temperature (3). This is achieved while very low transpirational rates are maintained (3) through daytime stomatal closure (2) and with contributions from other protective systems (2, 4). One of these is the epicuticular wax layer, which has been established to be an adaptation of plants to dry climates (5).

Cereus peruvianus is a columnar Cactaceae native to southeastern South America. It belongs to the tribe Cereeae, which includes over three-fourths of all cacti species (1). *C. peruvianus* was the first of the group to be described (by Tabernaemontanus in his Kreuterbuch, in AD 1625 (1)), and the name refers to the candelabrum-like branching of the species.

This report presents the first detailed analytical results for waxes from this family, there only being previous reports by Chibnall *et al.* for a sample from an unspecified *Opuntia* (6, 7) (the main components of that wax were described as the C_{35}, C_{33} and C_{37} hydrocarbons and the C_{28} and C_{30} n-alkanols, and were detected by indirect means) and by Herbin *et al.* (8) for the hydrocarbons of *Harrisia martini* (the main components were the C_{37}, C_{35}, C_{33} and C_{39} homologues).

RESULTS AND DISCUSSION

The total wax extracted represented 0.1% of the fresh plant material, an average of 1.5 mg/cm^2 of plant surface. This is high when compared with similar data for other plants (9). The isolated wax has a melting range of 58–63°. Column chromatography and preparative tlc were used to separate the different fractions, which include: hydrocarbons (65%), esters (10%), sterols (6%), free acids (5%), free alkanols (3%) and an as yet unidentified fraction (10%). The composition of the hydrocarbon, ester and free fatty acid fractions were determined by glc and are summarized in table 1.

The preponderance of the hydrocarbon fraction is quite marked, being higher than that in most waxes, including candelilla (57%), esparto (60%) and *Pisum sativum* (61%) waxes (10), but lower than that reported for *Solandra grandiflora* (92%) (8, 11). The main component in this fraction is the C_{31} homologue, something usual in plant waxes (11), but different from what is described for other cacti waxes (6, 7, 8).

The acid components, both in the ester and free fatty acid fractions, show a distribution with two superimposed series: a low molecular weight series with C_{16} and C_{18} as main constituents; and a high molecular weight series, with C_{28} and C_{26} as principal members. The free fatty acid fraction has mono-unsaturated constituents, not present as esters. The ester fraction has the C_{28}, C_{26} and C_{30}

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TABLE 1. Composition of *C. peruvianus* epicuticular wax. (Weight % determined by gas liquid chromatography).

Number of carbon atoms	Hydrocarbons	Hydrolysis products of esters		Free acids
		n-acids	n-alkanols	
12	—	—	—	tr
13	—	—	—	—
14	—	1	—	2
15	—	—	—	2
16	—	29	—	33
16:1	—	—	—	tr
17	—	1	—	1
18	—	17	—	11
18:1	—	—	—	18
19	—	1	—	tr
20	—	17	—	2
20:1	—	—	—	1
21	—	1	—	—
22	—	7	1	2
23	1	1	—	—
24	1	5	5	2
25	3	2	1	1
26	1	10	28	5
27	12	2	2	—
28	2	5	37	14
29	24	3	3	—
30	1	—	18	5
31	54	—	3	—
32	1	—	—	—
33	tr	—	—	—

n-alkanols as main components. This is similar to that found by Chibnall *et al.* (6, 7) in *Opuntia* sp.

EXPERIMENTAL

COLLECTION OF THE WAX.—*Cereus peruvianus* (L.) Miller (1) was collected at Punta Ballena (Maldonado, Uruguay), in January 1975. A voucher sample was kept as No. 106 in Mr. Miguel A. Muriel's Cactaceae Collection (Montevideo, Uruguay). The extraction of the wax was completed by dipping the fresh plant material in chloroform (15 seconds, to exclude internal lipids). The resulting chloroform solution was filtered and the chloroform was removed by evaporation.

SEPARATION OF FRACTIONS.—A sample of the wax (1.34 g) was applied on a Silica Gel column (Kieselgel, Woelm, 0.063–0.2 mm; 75 g). Hydrocarbons (870 mg) were eluted with hexane (350 ml); esters (135 mg) with hexane-chloroform (4:1; 500 ml); an unidentified fraction (130 mg) with a second fraction of hexane-chloroform (2:1; 300 ml); and a complex fraction (200 mg) with chloroform.

This complex fraction (105 mg) was separated by preparative tlc (Merck HF; 0.5 mm thickness; 20 cm) with chloroform as solvent. By repeated chromatography free fatty acids (45 mg, 6% of original wax), free alkanols (38 mg, 5% of wax) and sterols (22 mg, 3% of wax) were isolated.

THIN LAYER CHROMATOGRAPHY.—Tlc was performed with Silica Gel plates (Merck G; 0.25 mm thickness; 20 cm) with petroleum ether 60–80°-diethyl ether-

acetic acid (90:10:2) or chloroform as solvents. The plates were developed by use of sulfuric acid spray and charring. The different fractions were identified by comparison with standards of known composition.

GAS LIQUID CHROMATOGRAPHY.—Gas chromatograms were run on a Pye-Unicam model 104 gas chromatograph following established procedures (12, 13). The hydrocarbons were identified by use of the C_{27} synthetic homologue as internal standard. The methyl esters and the acetates were prepared according to standard procedures (12, 13) and identified by comparison against pure standards. The isolated free fatty acids were methylated with diazomethane.

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