The Wax of *Calathea lutea* (Marantaceae)

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Calathea lutea lives in rain forests of Central America. It produces a conspicuous wax coating on the under surface of the leaves. As contribution to the as yet rather poor chemical knowledge on the Marantaceae, the composition of this wax has been analyzed. By GLC and MS it could be shown to consist mainly of odd numbered *n*-alkanes and even numbered *n*-alkanols.

Calathea lutea (Aubl.) Schultes is a tall, large-leafed herb widely distributed throughout the neotropical region. Originally described from the Guyana rain forest, it is commonly found along the Carribean versant in Central America. It grows in conspicuous clumps covering extensive areas. It prefers wet or saturated soil and, like other Marantaceae and the related Musaceae, the unshaded areas of the tropical forest. The leaves of this plant are gathered by the natives and "serve in place of paper for wrapping all kinds of articles, especially salt and soap" [1]. The populations of *Calathea lutea* are easy to find because the tall leaves shine silvery white from a distance. This color effect is due to the accumulation of cuticular waxes on the under surface (hence the popular name "hoja blanca"). The wind can peel off the wax coating when the plants are experiencing a dry spell. It is common knowledge that the original inhabitants of the geographical range of *Calathea lutea* collected the wax, called "cauassú", and used it in the "curing" or waterproofing of bow-strings, in basketry, and as a multi-purpose lubricant. The wax may have also been used in the preparation of molds for the casting of gold artifacts by the "lost wax" method still in use by metalcraft workers.

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As well as a general lack of knowledge of the chemical characteristics of the whole family Marantaceae [2] next to nothing is known chemically about the wax of *Calathea lutea* [3]. Since the plant is so abundant, easy to propagate and to grow, we thought it important to investigate the chemical nature of this wax which may possibly open up a new source of products and applications.

Materials and Methods

Sliced leaves of *Calathea lutea*, collected in Costa Rica (Prov. Limon, october 1977) were air-dried and sent to Darmstadt. Most of the wax already had peeled off; this material as well as the remainder on the dried leaf slices was dissolved in benzene. Upon cooling of the filtered and concentrated solution most of the material precipitated. It was filtered off and dried to yield a powdery, slightly greasy, white product (11.04 g), with a fairly sharply defined melting point at 75 – 78 °C. After evaporation of the benzene the residue formed a slightly brownish mass (1.76 g), still liquid at 60 °C. The latter according to preliminary TLC results may contain traces of phytosterols, but is as yet not further analyzed.

A sample of the withe "powder" was dissolved in ether and analyzed by GLC (Perkin Elmer F-11) on a $5' \times 1/8''$ column packed with 5% SE-30 on Chromosorb W 80/100 and a FID detector. Temperature was 150 °C for the first 5 min after injection, then raised to 300 °C at a rate of 5 °C/min. Acetylation of the wax was effected by treatment with Ac_2O/pyr at 20 °C for 24 h. The acetylated mixture was analyzed by GLC under the same conditions as the native wax. Mass spectrometry was carried out on an AEI MS 902 mass spectrometer with a PDP 8 computer attached (direct inlet, temp. 120 °C, IP 70 eV).

The alkanes used as reference compounds were purchased from B. Newton Maine Ltd. (up to C_{19}), Th. Schuchardt GmbH ($C_{20} - C_{26}$) and Fluka AG (C_{28} and up); C_{27}, C_{29} and C_{31} were from *Myrica gale* leaf wax [4]. Alkanols were from Fluka AG (up to C_{26}), and a mixture of *n*-alkanols was synthesized ($C_{21}$and up) by saponification and isolation of the *n*-alkanol fraction from carnauba wax [5].

Results and Discussion

As shown in Tables I and II, the wax of *Calathea lutea* consists mainly of odd numbered *n*-alkanes, $C_{25}-C_{31}$, and of even numbered *n*-alkanols, $C_{20}-C_{32}$. The main products are the *n*-alkanes, C_{27} and C_{29}, and the *n*-alkanol, C_{24}. A peak of 2% intensity at T_{rel} 1.17 as well as a second peak of less than 1% intensity are not identified. In contrast to the alkanes, the alkanols gave no M^+ peak, but only M-18 peaks, due to loss of water from the molecular ion. In the mass spectrum of the acetate mixture, M^+ peaks for the alkanes as well as for the alkanol acetates previously identified by GLC were observed. In addition, small peaks (less than 5% of the peak at m/e 396, corresponding to $C_{24}H_{49}OAc$) appeared at m/e 508, 536 and 564, corresponding to the acetates of the *n*-alkanols, C_{32}, C_{34} and C_{36}. In GLC of the acetylated wax unidentified peaks of more than 1% intensity were found at T_{rel} 0.68 (2%) and 1.03 (2%).

With regard to its chemical composition, the wax of *Calathea lutea* fits into the range of many "normal" cuticular waxes, which are composed of *n*-paraffins of odd carbon numbers and *n*-primary alcohols of even numbers [6]. So it is not so much the chemical constitution of this material which makes it interesting but rather its rich production by the leaves. Average yield of wax has been reported to be 0.7 g/leaf [7]. – The wax layer certainly will retard both wetting and drying out, as assumed for other wax coatings, too [8]. Furthermore it may be a biological control against infections and herbivory. The foliage of *Calathea lutea* is rather intact when compared with other non-ceriferous Marantaceae, the leaves of which are usually pierced by beetles.

In reference [7] it has been suggested that "The coating ... is a potential source of commercial wax that is similar to, and can be used for the same purposes as, carnauba, the best wax known. Extracting wax from *Calathea lutea* could be developed into a productive cottage industry, particularly suited to isolated regions". Interestingly enough, the chemical constitution of carnauba wax, obtained from the Brazilian palm *Copernicia cerifera*, is rather different from that of *Calathea lutea*. Carnauba wax, the most important wax of plant origin, consists of 84 – 85% of alkyl esters of wax acids, a certain amount of free acids, lactones, and only 1.5 – 3% of hydrocarbons [3]. *Calathea* wax is more similar to the important candelilla wax (from *Euphorbia cerifera*), which consists of 42.5 – 59.7% of hydrocarbons and has the same melting point as the *Calathea* wax [3]. The estimated yield of crude wax according to ref. [8] might be 800 kg per ha. Since the plant is one of the first secondary-growth species to colonize newly disturbed areas (*e. g.* by fire, be it natural or man-caused), there are extensive populations in the wild and it can be used in wastelands not suited to other agricultural purposes. Hence it really might play a role as source of commercial wax.

Table I. GLC and MS data for native wax (for T_{rel} $C_{29}H_{60}$ = 100).

Structure assigned	M^+	M^+-18	T_{rel}	% of total
n-$C_{20}H_{41}OH$		280	0.74	1
n-$C_{25}H_{52}$	(352)		0.78	4
n-$C_{22}H_{45}OH$		308	0.86	8
n-$C_{27}H_{56}$	(380)		0.89	14
n-$C_{24}H_{49}OH$		336	0.96	21
n-$C_{29}H_{60}$	(408)		1.00	26
n-$C_{26}H_{53}OH$		364	1.07	6
n-$C_{31}H_{64}$	(436)		1.11	8
n-$C_{28}H_{57}OH$		392	1.20	3
n-$C_{30}H_{61}OH$		420	1.26	2
n-$C_{32}H_{65}OH$		(448)	1.29	1

Table II. GLC and MS data for acetylated wax.

Structure assigned	M^+	T_{rel}	% of total
n-$C_{25}H_{52}$	(352)	0.79	5
n-$C_{20}H_{41}OAc$	(340)	0.81	2
n-$C_{27}H_{56}$	(380)	0.90	17
n-$C_{22}H_{45}OAc$	368	0.92	7
n-$C_{29}H_{60}$	(408)	1.00	27
n-$C_{24}H_{49}OAc$	396	1.10	24
n-$C_{31}H_{64}$	(436)		
n-$C_{26}H_{53}OAc$	424	1.19	7
n-$C_{28}H_{57}OAc$	452	1.27	3
n-$C_{30}H_{60}OAc$	(480)	1.35	1

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