dium sulfate and evaporating yielded 1.23 g. of a semisolid. The ultraviolet spectrum showed $\lambda_{max.}^{EtOH}$ 275 mμ (E 50.0), and the infrared spectrum showed a peak at 6.25 μ (β-diketone). This semisolid was esterified and treated with cupric acetate in methanol (1); the yield was 0.070 g., m.p. 90–92°C. The complex was decomposed and 0.063 g. of esters were isolated by ether extraction. Saponifying the mixture of dioxoesters yielded 0.056 g. of acids. These acids were oxidized by peracetic acid (1), and 0.037 g. of oxidation product was recovered by ether extraction. GLC analysis showed that pelargonic and octanedioic acids were the major degradation products. Nonanedioic and heptanedioic acids were also observed in smaller quantities. The heptanedioic acid may have resulted from degradation of octanedioic acid.

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REFERENCES

1. Nunn, J. R., J. Chem. Soc., 313 (1952).
2. McFarlane, J. J., Shenstone, F. S., and Vickery, J. R., Nature, *179*, 830 (1957).
3. Craven, B., and Jeffrey, G. A., Nature *183*, 676 (1959).
4. Shenstone, F. S., and Vickery, J. R., Poultry Science, *38*, 1055 (1959).
5. Faure, P. K., Nature, *178*, 372 (1956).
6. Faure, P. K., and Smith, J. C., J. Chem. Soc., 1818 (1956).
7. Durbetaki, A. J., Anal. Chem., *28*, 2000 (1956).
8. Smith, C. R. Jr., Wilson, T. L., and Mikolajczak, K. L., Chem. and Ind. (London), 256 (1961).
9. Shenstone, F. S., and Vickery, J. R., Nature, *190*, 168 (1961).
10. Hofmann, K., Lucas, R. A., and Sax, S. M., J. Biol. Chem., *195*, 473 (1952).
11. Hofmann, K., Jucker, O., Miller, W. R., Young, A. C., and Tausig F., J. Am. Chem. Soc., *76*, 1799 (1954).
12. Hofmann, K., and Liu, T. Y., Biochim. Biophys. Acta., *37*, 364 (1960).
13. Goldfine, H., and Bloch, K., presented at the Division of Biological Chemistry, 138th Meeting, American Chemical Society, New York, N. Y., Sept. 11–16, 1960; J. Biol. Chem., in press (1961).
14. Bloomfield, D. K., and Bloch, K., J. Biol. Chem., *235*, 337 (1960).
15. Lennarz, W. J., and Bloch, K., J. Biol. Chem., *235*, PC 26 (1960).
16. Hopkins, C. Y., and Chisholm, M. J., J. Am. Oil Chemists' Soc., *37*, 682 (1960).
17. Smith, C. R., Jr., Burnett, M. C., Wilson, T. L., Lohmar, R. L., and Wolff, I. A., J. Am. Oil Chemists' Soc., *37*, 320 (1960).
18. Brotherton, T., and Jeffrey, G. A., J. Am. Chem. Soc., *79*, 5132 (1957).
19. Craven, B., and Jeffrey, G. A., J. Am. Chem. Soc., *82*, 3858 (1960).
20. Von Rudloff, E., J. Am. Oil Chemists' Soc., *33*, 126 (1956).
21. Von Rudloff, E., Can. J. Chem., *34*, 1413 (1956).
22. Gunstone, F. D., J. Chem. Soc., 1611 (1954).
23. Rinehart, K. L. Jr., Goldberg, S. I., Tarimu, C. L., and Culbertson, T. P., J. Am. Chem. Soc., *83*, 225 (1961).
24. Miwa, T. K., Mikolajczak, K. L., Earle, F. R., and Wolff, I. A., Anal. Chem., *32*, 1739 (1960).

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The Cuticle Wax of the Cuban Palm, *Copernicia hospita*

E. D. KITZKE and E. A. WILDER, Basic Research Department, S. C. Johnson & Son, Inc., Racine, Wisconsin

The physical and chemical constants characterizing a previously unreported palm wax are given. These are compared to and are quite similar to those of carnauba. There is also reference to certain gross field characteristics such as leaf size, age at time of flowering, and wax yields. The wax compares favorably with carnauba in typical polish compositions.

INTENSIVE FIELD STUDIES have been underway for over 18 years to better establish the taxonomy of the West Indies and South American species of the genus *Copernicia*. A portion of the data gathered has recently appeared as a published monograph (1). Several of the species of this genus have been called to the authors' attention because of unusual waxy character found in the leaves.

A substantial number of plants representing various Cuban species of this genus have been grown from seed under experimental wax palm plantation conditions in northeast Brazil (2). Because it was possible to simulate typical field conditions equivalent to what the commercial Brazilian carnauba (*Copernicia cerifera*, Martius) wax palms receive, it has also been possible to harvest the waxes of these currently unexploited palms and draw direct comparisons to the carnauba palm. The chemical analyses for one of these palm waxes have been completed and are reported here.

The *Copernicia hospita* palm has been regarded from the early taxonomic studies and early field work in Cuba (3) to be an outstanding candidate for wax production. Trees of this species being grown in northeast Brazil are already showing evidence (Fig. 1) of botanical maturity (flowering) and adequate size capable of withstanding the severe pressure of annual leaf cutting harvest at the age of five years. Carnauba *(C. cerifera)* does not reach maturity (flowering) before 12–15 years of age and does not provide commercial wax yields before it is 8 years old.

The leaves in this study were collected using techniques commonly practiced by the native harvesters of carnauba in Brazil. They were excised from the crown and sun-dried for five days. The wax was removed from the leaves by a mechanical beating process using a Guarani-cyclone machine. In this process the dried leaves are automatically cut into pieces 2–3 in. long and beaten by revolving arms in the body of this machine and the free flaking wax powder thus dislodged is collected by a cyclone air separator. The free flaked wax was then screened using a 40-mesh sieve in order to remove most of the vegetable fragments and fibers.

A quantity of the screened powder was melted and clarified by filtration. The several routine constants generally determined on waxes were run on the clarified wax with the results tabulated below and compared with like constants on carnauba. Notable differences between the two waxes occur in the higher

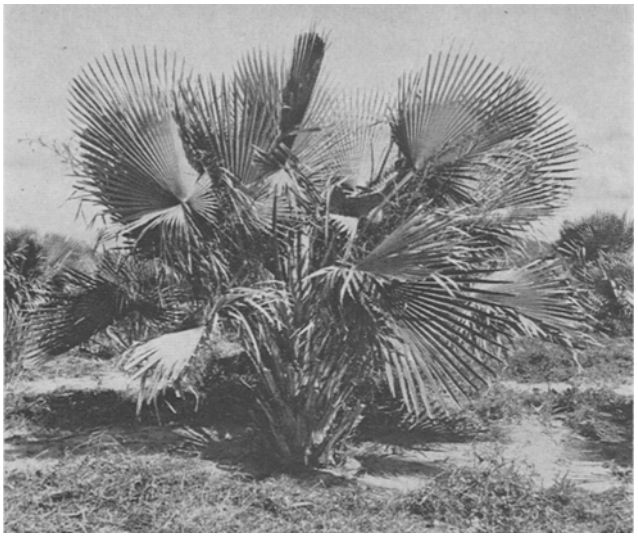

FIG. 1. *Copernicia hospita,* six-year old waxy palm. This Cuban species grown under plantation conditions in northeast Brazil achieves harvestable size in five years.

acid value, saponification value, melting point, and hydroxyl number of the wax from *C. hospita.*

The wax after melting and solidification is hard and greenish tan in color with a glossy, resinous surface. It is harder and more friable than carnauba (used generally as a hard vegetable wax standard). In naphtha based polishes it does not provide quite the firmness of paste that carnauba does, but the buffed films from comparable product composition favor the *C. hospita* wax slightly for gloss and buffing qualities. *C. hospita* wax emulsifies well in standard high wax content emulsion polish systems and provides waxy buffable films of good quality.

	C. hospita	*C. cerifera*
Acid value	16	6–12
Saponification value	101	70–85
Melting point	86°C.	82–85°C.
Hydroxyl value	59	55
Needle penetration 100 g./5 sec.	<1	<1
Hydrocarbon content	1.0%	1.0%
Solubility in 25°C. acetone	0.9%	1.5%

Infrared absorption spectra of *C. hospita* wax and carnauba wax indicate a strong similarity in the two waxes. The only marked difference occurs in the bands at 1600, 1518, and 830. Here the indication is that carnauba contains a hitherto unreported para substituted aromatic compound while the *C. hospita* does not.

The leaf sizes from a 1350 leaf sample when compared to carnauba were found to be relatively large having a dry weight ranging from 200 to 300 g. This is considerably larger than the well established 150 g. average for the palm *C. copernicia.* This sampling of leaves from approximately 150 palms yielded an average in excess of 5 g. free flaking wax per leaf. Despite drying conditions which were not optimum, the wax yield proved superior to that obtained from average carnauba. Extraction studies reveal that substantial additional quantities of wax can be obtained by solvent stripping. These additional yields indicate that the total wax harvest from a *C. hospita* leaf would be approximately three times that which can be obtained from the Brazilian species.

Additional studies are being run to determine optimum drying conditions that will provide greater free flaking wax yields for *C. hospita.* The only present commercial processes for harvesting wax from this type of palm leaf utilize mechanical methods requiring a wax that separates freely from the dry leaf.

REFERENCES

1. Dahlgren, B. E., and Glassman, S., Gentes Herbarum, Vol. *9,* Fasc. 1, (Aug. 1961).
2. Kitzke, E. D., Principes, *2,* 5 (1958).
3. Unpublished data.

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