

OCCURRENCE OF CAROTENE IN THE OIL OF *ATTALEA*
GOMPHOCOCCA MART. AND ITS RELATION TO
VITAMIN A POTENCYWILLIAM JOHN BLACKIE¹ AND GEORGE R. COWGILL,
*Laboratory of Physiological Chemistry, Yale University,
New Haven, Connecticut*

(Received for publication, July 8, 1938)

From time to time reference has been made in the literature to the presence of carotene in palm oils. Gill (1918) has reported its presence in the oils of *Elaeis guineensis* (L. Jacq), the African palm, and *Elaeis melanococca* (Garb), the South American species. Rose-dale (1935) has recorded a vitamin A potency for the red palm oil of Malaya, *Elaeis guineensis*, of 1,200 yellow units per gram and has further stated that this value has been confirmed by feeding experiments, although the results of the feeding trials are not included in his report. The occurrence in palm oil of carotene (from which the organism can obtain vitamin A through metabolic processes) in amounts almost equivalent to one-half the vitamin A potency of cod liver oil renders the oil of *Elaeis guineensis* a valuable source of the fat-soluble A factor.

The literature available does not furnish data for other species of *Elaeis* nor for palm oils generally, nor have we been able to trace for *Elaeis guineensis* references dealing with variations in carotene content with locality.

We have been interested for some time in nutrition studies connected with native races in the Pacific and Panama, and our initial studies have been concerned more particularly with food values and food-deficiency diseases.

In the course of a preliminary survey of Panama under the auspices of the Gorgas Memorial Laboratory in Panama City, samples of oil prepared from a palm indigenous to the region were secured, and it was deemed desirable to examine them from the point of view of carotene and vitamin A content. These oils are used in the Chagres river area for cooking and cosmetic purposes, and were prepared by the natives of that region.²

According to Standley (1928) two genera of oil palm occur in Central and South America, namely *Elaeis* and *Attalea*. *Elaeis mel-*

¹ Commonwealth Fund Service Fellow.

² We wish to thank Dr. Herbert C. Clark, Director, and various members of the staff of the Gorgas Memorial Laboratory for obtaining the oils here studied. The samples represent the oils prepared and used by the natives in the village of New San Juan and vicinity, Republic of Panama.

anococca Gaert. is common in the Central American region, is rich in oil, and is known locally as "corocito colorado," "coquito," and "palmiche," the latter two names being common in Costa Rica. Of the *Attaleas*, the *gompococca* Mart. is one of the largest and most common palms of southern Central America and is known in Panama as "corozo," "corozo gallinazo," and "palm real." Both the oil obtained from the cortex and that yielded by the kernel of the corozo palm nut are used by the natives in rice cooking, and the oil from the cortex is employed as a medicine for colds and cosmetically as a hair dressing.

The samples of oil examined were obtained from the cortex and kernel of the nuts of two varieties of corozo palm, namely "corozo negro" and "corozo gallinazo." We were concerned more particularly with the outer or true palm oils as distinct from palm kernel oil.

EXPERIMENTAL PROCEDURE

The oil constants for the experimental oils, as determined by the official A.O.A.C. methods (1935), are presented (Table 1) with the values for related oils as given by Bolton and Revis (1913) presented for comparison.

TABLE 1
Properties of Experimental and Reference Oils

Oil	Color	Consistency at 20°C. (68°F.)	Saponification No.	Iodine No. (Hanus)	Non-saponification No.
Experimental					
Cortex oil—"corozo negro".....	Red	Fluid	187.1	87.1	1.54
Cortex oil—"corozo gallinazo".....	Red-yellow	Fluid	191.0	77.6	0.94
Kernel oil—"corozo negro".....	Pale yellow	Semi-solid	245.7	15.4
Bolton and Revis (1913)					
Normal palm oil.....	Red	Fluid	199.2	56.3
Normal palm oil.....	Cream	Semi-solid	246.2	14-19	0.12
Cobune oil.....	Cream white	Semi-solid	254-260	9-12.5

From the table it will be observed that in general the oils of *Attalea gompococca* are related to those of the true palms but that the oils obtained from the cortex have much higher iodine values.

Examination of Non-Saponifiable Matter for Carotenoids: The intense reddish color of the oils suggested the presence of carotenoids,

and the production of a green coloration upon treatment of the original oil with ferrous chloride confirmed this suggestion. The absence of coloration with concentrated sulfuric, hydrochloric, and nitric acids, when added to an alcoholic solution of the non-saponifiable matter, suggested that the carotenoids present were of the carotene type.

Fifty grams each of the cortex oils dissolved in 200 c.c. of alcohol were saponified with 25 per cent of KOH solution. The soap solutions were evaporated to dryness under a reduced pressure of CO₂, taken up in water, and the water solution of the soaps thoroughly dried and then extracted with successive small quantities of petroleum ether—b.p. 40 to 60°C. (104 to 140°F.). The petroleum-ether solution was golden yellow in color and the color remained on shaking with 90 per cent alcohol, indicating the absence of xanthophylls, rhodoxanthin, and fucoxanthin. The petroleum-ether solution and solutions of the non-saponifiable matter in benzene and carbon-disulfide were subjected to a chromatographic analysis using columns of finely divided chalk and chromatographic alumina. In all cases an examination of the columns failed to show banding, indicating the absence of carotenoids of the xanthophyll type. The carbon-disulfide solution was blood red in color and the benzene and petroleum-ether solutions golden yellow.

A spectroscopic examination of the solutions of the non-saponifiable matter was made with a pocket spectroscope. Two bands were observed in the green and blue in benzene solution and a shift of the bands was observed in carbon-disulfide solution. The approximate readings obtained with the instrument available showed the bands to occur thus: Band 1 at from 530 to 510 m μ , and Band 2, from 490 to 470 m μ . The bands were perfectly plain at the right dilution, no continuous spectrum, such as would have been occasioned by the presence of lycopin in admixture with carotene, being observed.

The spectroscopic observations point to the absence of xanthophylls, rhodoxanthin, and lycopin; this latter carotenoid was further excluded by the absence of a bluish tint in the carbon-disulfide solution of the nonsaponifiable matter persistent with dilution. The material under examination became yellow on great dilution.

Owing to the small quantity of oil available for examination it was not possible to isolate the carotenoids, but the observations recorded above point strongly to the presence of a single lipochrome or closely related lipochromes of the carotene type.

Biological Tests for Vitamin A: Young rats 21 to 28 days old were fed the "depletion diet" specified by the United States Pharmacopoeia (1936) until they ceased to gain weight and had devel-

oped definite eye symptoms indicative of vitamin A deficiency. The animals were then distributed into assay groups in accordance with the requirements of the official U.S.P. assay method. Six animals suitably chosen for weight uniformity and sex distribution were assigned to each group.

The experimental oils were fed at two levels for each oil, and in addition one control and one reference group were run at the same time as the assay groups.

It was found that dosages of 22 mg. for the "corrozo negro" cortex oil and 78 mg. for the "corrozo gallinazo" cortex oil were required daily to restore the animals to health and promote a gain in weight of not less than 12 and not greater than 60 grams over the assay period as required by the U.S.P. method. A dosage of 1.2 mg. daily of the standard pharmacopoeia cod liver oil was fed to the reference group. In the control group four of the six animals had died as a result of vitamin A deficiency before the completion of the assay period.

The data obtained from the assay and the reference groups may be summarized as follows: "Corrozo negro" cortex oil, fed at a daily level of 22 mg., produced an average gain in weight over the test period of 36.8 gm.; "corrozo gallinazo" cortex oil, fed at a daily level of 78 mg., produced an average gain of 40 grams over the assay period; standard reference cod liver oil, fed at the daily level of 1.2 mg., produced an average gain in weight of the reference group, over a similar period, of 38.2 gm. The reference oil contained 3,000 international units of vitamin A per gram. It is obvious from the above figures that the test palm oils do not conform with the United States Pharmacopoeia standard of 600 international units or over per gram of cod liver oil. A simple calculation indicates that the "corrozo negro" cortex oil contains the equivalent of about 158 I. U. of vitamin A per gram, and the "corrozo gallinazo" cortex oil about 48 I. U. per gram.

SUMMARY

By chemical, physical, and feeding experiments it was shown that carotenes occur in the cortex oils of two varieties of the nuts of *Attalea gumpococca*, a palm occurring in Panama.

Vitamin A potencies were determined by feeding experiments and proved to be about 158 I. U. per gram for the cortex oil of the "corrozo negro" variety, and about 48 I. U. per gram for the "corrozo gallinazo" sample.

These vitamin A values, determined biologically, are well below those recorded by Rosedale (1935) for the oil from another variety of palm, *Elaeis guineensis*.

REFERENCES

- BOLTON, E. R., AND REVIS, C., 1913. *Fatty Foods: Their Practical Examination*, Blakiston & Sons, Philadelphia, Pa.
- GILL, A. H., 1918. The occurrence of carotin in oils and vegetables. *J. Ind. Eng. Chem*, 10, 612-614.
- Official Methods of the A.O.A.C., 1935. 4th ed.
- Pharmacopoeia of the United States, 1936. XI, 480-482.
- ROSEDALE, J. L., 1935. *Chemical analyses of Malayan foods*, Singapore Govt. Printer.
- STANDLEY, P. C., 1928. *Flora of the Canal Zone*. U. S. National Museum, Contribution from the National Herbarium 27, 100.