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Caranday–A Source of Palm Wax

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THERE exists in Paraguay a species of waxy-leaf palm commonly referred to as caranday (*Copernicia australis* Becc.), which in many respects is similar to the carnaúba palm (*Copernicia cerifera* Mart.) of Brazil. Both palms elaborate waxy coatings which reflect their respective environments. At first thought it would not seem that two such widely separated regions as the *sertão* plains of northeastern Brazil and the Gran Chaco would have much in common. To some extent this is true, but certain geographic and climatic similarities can be observed which are sufficient to account for the elaboration of the waxy coatings in the palms which are indigenous to each region.

The carnaúba palm, which is the source of the carnaúba wax of commerce, is found principally in northeastern Brazil in the States of Ceará, Piauí, Rio Grande do Norte, and Maranhão. Although the carnaúba palm is numbered in the millions and is found throughout an area of about 1.5 million square miles, the wax industry is centered in the States of Ceará and Piauí. The natural habitat of the palm is an area subject to torrential rains and floods during a part of the year followed by scorching heat and fierce winds which dry and parch the soil to an extent that few plants are able to survive. The period of drought in Ceará may last for a year and sometimes longer. The carnaúba palm is able to exist in such an unfavorable environment by virtue of the fact that it possesses an extensive root system highly adapted to garnering during the dry season the little available water and because of its ability to elaborate an extremely effective protective coating against excessive evaporation of water through its leaves. This protective coating is the source of the carnaúba wax of commerce.

It has heretofore been believed that only in northeastern Brazil could there be found an environment and a palm such as has just been described. However, portions of the Gran Chaco can be compared with the *sertão* plains of northeastern Brazil, and the millions of caranday palms in that area can be compared with the carnaúba palm. The primary difference is that normally the periods of drought are shorter in the Chaco than in northeastern Brazil, and until about a decade ago the caranday palm was not recognized as a commercial source of hard vegetable wax potentially as great as the carnaúba palm.

Like the *sertão* plains of northeastern Brazil, the Gran Chaco comprises a vast flat, semi-arid plain devoid of major topographic features. This vast plain extends from the west bank of the Río Paraguay to the eastern foothills of the Andes and from the Río Salado in Argentina to the Santa Cruz plains in Bolivia, occupying parts of Argentina, Paraguay and Bolivia.

The Chaco is essentially a low-lying country of little elevation and less relief, and large areas are therefore inundated during the rainy season or are flooded by the rising Paraguay and its tributaries which back their waters into the lowlands. In contrast to the uniformity of relief, the surface soils display considerable diversity owing to varying distances from the rivers and the nature of the underground drainage. In general, the soils vary from fine sands to heavy clays which are often impregnated with salts during the periods of drought. North of the Río Pilcomayo and west of the Paraguay for a distance of 400 miles no stream has carved a channel in the recent alluvial sediments. Only sluggish meandering and ill-defined streams drain the rainfall from this area. During the rainy season (November to April) the Chaco receives 20 to 55 inches of rainfall which floods vast areas and converts it into a lake-dotted land. This is followed by a season of desiccation (May to October) when little rain falls, lakes and water holes dry up or become saline, and the meandering streams become mere ribbons or dry beds.

The Gran Chaco lies approximately between 20° and 30° south latitude, and its climate is therefore subtropical to tropical with considerable variation in temperature. In the southern portion minimum temperatures are near freezing in winter while in the northern portion frosts are practically unknown. Maximum summer temperatures are considerably in excess of 100°F. and may be as high as 110° in the northern portions. Sudden changes in temperature result from the rapid and rather frequent changes in winds from the hot north to the chilling south.

Owing to the variation in climate, soils, and drainage, the natural vegetation of the Chaco is unusually non-uniform. At varying intervals are found scrubby and thorny bushland (monte), grasslands (campo), palm groves (palmares), hardwood dicotyledonous forests (monte duro), and swamps (esteros). The extent of each of these varies from small patches or islands to relatively vast areas.

The Paraguayan Chaco is a source of appreciable national wealth. Besides cattle and some agricultural products, the forests produce timber, tannin (quebracho), and essential oil (palo santo). The caranday palm is another important resource which is but little exploited, principally for timber (telephone and telegraph poles, farm structures, etc.) and as a source of fiber (ropes, bags, hammocks, etc.), and leaf straw for the manufacture of hats (1). Potentially the caranday is much more valuable as a source of hard vegetable wax than for any other of the aforementioned palm products.

[1] A U. S. Government Point Four Agency.

FIG. 1. Typical specimen of caranday palm (*Copernicia australis* Becc.).

The caranday palm, also called carandaí, carandá, palma negra, and other names, averages about 30 feet in height and has a trunk 7 to 10 inches in diameter. Although, in general, the caranday cannot be ranked with the tall palms of the world, occasional trees attain a height of 60 to 70 feet or more. The young trees retain the spiny basis of the leaves, but these are eventually shed and expose the dark colored and very hard trunk (Figure 1). Over wide areas the palm stems have a dark stain marking the level reached by flood water.

Superficially the caranday palm (*Copernicia australis* Becc.) resembles the carnaúba (*Copernicia cerifera* Mart.) of northeastern Brazil, and it is easy to confuse the two species. They have however been carefully described and distinguished by the Italian botanist, Beccari (2), who studied the genus *Copernicia*. Among the differentiating characteristics Beccari noted the following:

1. The leaves of adult plants in *C. australis* (caranday) have the surface covered on both sides with numerous minute reddish points or dots; the points are lacking or very few and scarcely visible in the adult leaves of *C. cerifera* (carnaúba).
2. In *C. australis* the branches of the third and fourth order arise inside a tubular funnel-form spathe; in *C. cerifera* there are only tubular spathes for the second order, and only from these arise the branches which then subdivide into floriferous branchlets.
3. The flowers in bud of *C. australis* are about twice as long as those of *C. cerifera;* in the latter the ovary is scarcely pilose at the top while it is densely pilose in *C. australis;* the style in the latter is slender and the stigma punctiform, while in *C. cerifera* the style is relatively thick and the stigma distinctly 3-lobed; the stamens in *C. cerifera* form a fleshy ring with six very tiny teeth representing the filaments, in *C. australis,* on the contrary, the filaments have a broad triangular base, which is abruptly contracted into a fairly long subulate filament; the tube of the corolla has six raised crests in *C. cerifera* and is smooth in *C. australis.*
4. The fruit of *C. australis* is smaller than that of *C. cerifera.*

Owing to the difficulty and confusion of distinguishing the two palms Kuhlmann (3) prepared illustrations which permit a precise and easy means of recognizing and differentiating the two palms in the field or by means of herbarium specimens. These illustrations are reproduced in Figure 2.

Although the caranday palm has long been exploited for a variety of purposes, its value as a source of hard vegetable wax has only received consideration in the past decade. This has probably been due to the isolation of part of the caranday area in Bolivia and Mato Grosso (Brazil), and in Paraguay to the greater economic importance of quebracho, palo santo, and other trees in the accessible areas along the Río Paraguay and its tributaries.

The first study of the anatomic structure of the leaf of the caranday palm was reported by Dodsworth Machado (4). The leaf material for this study was collected in 1943 in the vicinity of the Guaicurús Falls in Mato Grosso, but the results were not published until December 1945, simultaneously with a study of the formation and properties of wax by de Medeiros Trancoso (5). The latter publication mentions the small-scale production of caranday wax by primitive means by Ayrton Pacheo at a point about 36 miles below Porto Murtinho on the Brazilian side of the Río Paraguay.

Subsequently the firm of Carlos Casado Ltda. became interested in the commercial exploitation of the caranday palm as a source of wax. This firm operates a large quebracho extraction plant at Puerto Casado and owns about 2.5 million acres of land in the Chaco along the Río Paraguay, which contains extensive stands of caranday palm. In 1947 the firm began an intensive laboratory investigation of the yield and variation of caranday wax in relation to the conditions of harvesting and drying the leaves. This inves-

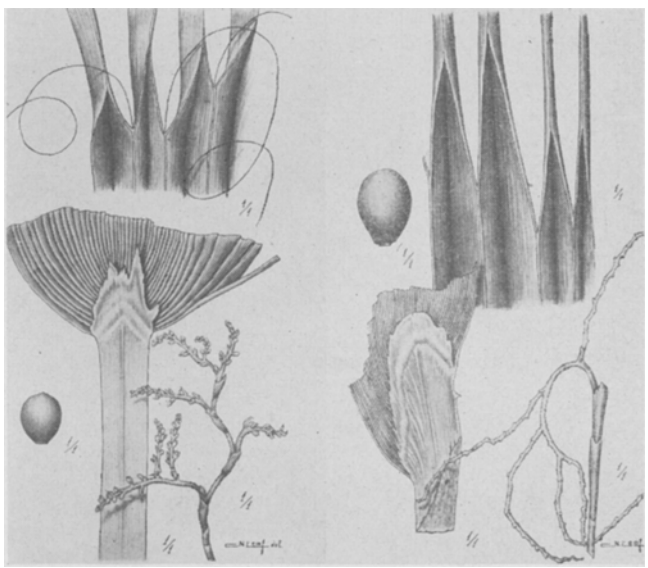

FIG. 2. Comparison of differentiating characteristics of the leaves, fruits, and flowers of the caranday (right) and the carnaúba (left) palms, according to Kuhlmann (5).

tigation included the palms on the Chaco as well as the Brazilian side of the Río Paraguay in the vicinity of Puerto Casado. Subsequently (1949) a pilot plant for recovering wax was erected.

A second pilot plant was erected by the Sociedad Forestal de Puerto Guaraní, another quebracho extraction firm, located at Puerto Guaraní, 70 miles farther north. This installation includes a building for drying leaves, two machines for separating the wax powder, a melting vessel, and a centrifuge for separating the wax from the dirt and leaf trash. Sociedad Mercantil Colectiva "P.A.A.M.," S. A. Agro-Industrial y Comercial Espinosa Ltda., and other firms have developed equipment or experimented with the production of caranday wax.

In 1950, 1,297 kilos of caranday wax were imported into the United States under the classification Paraguayan carnaúba. The wax was valued at $970 f.o.b. New York, or 75 cents per kilo, whereas the total import of carnaúba for that year averaged somewhat more than $1.70 per kilo (6). The low price received for caranday wax compared with carnaúba was one of several factors which resulted in closing the pilot plants and stopping further efforts to develop a caranday wax industry in Paraguay.

Another problem which confronted the producers resulted from the grant of a series of monopolistic patents (7) late in 1949 and early in 1950. The validity of these patents was questioned almost immediately through the medium of a suit brought by a potential producer of caranday wax. The suit was finally decided in favor of the patentee, but the patents were subsequently voided by a decree law (8).

In the course of a survey of the vegetable oil resources of Paraguay the writer attempted to appraise the technical and economic possibilities of both small and large scale exploitation of the caranday palm as a source of hard vegetable wax. The pilot plants of two of the quebracho firms located on the Río Paraguay were inspected, laboratory records were examined, samples of wax were obtained and sent to various firms in the United States for analysis and evaluation, and several aerial and ground surveys were made of the distribution and extent of the caranday palm.

Yield of Wax Per Leaf. Examination of the laboratory records covering harvests made in 1947 and 1948 in the vicinity of Puerto Casado indicated that the yield of wax per leaf varied with the age of the leaves, weather preceding harvesting, conditions of drying, etc. Unselected leaves harvested after two or four days of rain and wind gave only 1.5-2.1 g. of wax;[2] selected leaves, *i.e.*, no old or dying leaves, gave 3.8-4 g. of clean wax; unopened or oleo leaves gave 3.5-4.4 g. of clean wax. Little difference was observed in the yield of wax from palms on the Chaco and on the Brazilian side of the Río Paraguay. Various authors have reported that the carnaúba palm yields 4-5 g. of wax per leaf, but none state whether the figures refer to crude wax powder or to clarified wax and, if the latter, of what degree of purity.

In comparing the relative yield of wax per leaf of caranday and carnaúba, the marked difference in the total surface areas of the leaves of the two palms should be borne in mind. According to Beccari (2) the mature carnaúba leaf is composed on the average of 60 leaflets, the central one of which is approximately 85 cm. in length and 35 mm. wide at a distance 7-8 cm. above the point of fission. The mature caranday leaf is composed on the average of 48 leaflets, the central one of which is approximately 65 cm. in length and 35-40 mm. wide slightly above the point of fission. At the same point the two outermost leaves are only 7-15 mm. wide. If the data given by Beccari are representative for the two palms, it would appear that the total surface per leaf of the carnaúba is appreciably larger than that of the caranday. The leaf areas of the carnaúba and caranday appear to be roughly in the ratio of 5:3 or, stated in another way, the total surface per leaf of the carnaúba palm is approximately ⅔ greater than that of the caranday whereas the yield of wax is only ⅛-¼ larger.

Pilot Plant Production. Caranday wax has been produced on a pilot plant scale by several firms in Paraguay. These plants have used various types of machines for recovering the wax from the leaves after drying them either in a special drying house or outdoors. The light gray, fluffy powder is removed from the leaves by aspiration with air while the latter are being beaten or cut in the machines.

The aspirated wax powder accumulates in a closed room or bin, into which the aspirator duct leads. In one process the powder is first purified by continuous bolting through fine cloth or woven wire screen before it is melted by indirect steam and filtered prior to running to small shallow pans where it is allowed to solidify. In another process the crude wax powder is melted with direct steam and hot water, and the extraneous dirt and leaf trash separated by centrifuging. The separated liquid is run into large shallow pans where the water and wax separate into two layers as the wax slowly solidifies. After cooling, the cakes of hard wax, 0.75-1.5 inches thick, are broken into irregular pieces and bagged prior to shipment.

Quality of the Wax. When fractured, the hard dense wax exhibits a yellowish green to light brownish green color. It is readily bleached to a pale tan color by very small amounts of benzoyl peroxide and to a pale cream color by hydrogen peroxide-chromic-sulfuric acid.

Samples of the wax were submitted to various firms in the United States and abroad for examination and evaluation in product formulation tests. All but one firm reported that the wax was superior to ouricury and comparable to the higher grades of carnaúba wax. The principal physical properties are shown in Table I together with similar data from the literature for carnaúba, ouricury, and candelilla waxes.

TABLE I

Comparison of Caranday With Other Hard Vegetable Waxes

Characteristic	Carnaúba	Ouricury	Caranday[a]	Candelilla
Specific gravity 25°/4°	0.990-0.999	1.0661	0.990[b]	0.982-0.993
Acid value	4.0-9.7	21-24	9.5	12-20
Iodine value	7-14	6.9-7.1	8.0[b]	15-37
Acetyl value	54.8-55.2	.....	40[b]	.....
Saponification value	79-95	61.8-85.3	64.5	46-65
Melting point, °C	83-85	79-84	84.5[c]	64-71
Moisture, %	.....	.....	0.9	.....
Ash, %	.....	0.55-1.9	0.18	.....
Acetone-soluble at 25°C	2.0-2.5	.....	2.7	20

[a] Wax produced by Carlos Casado, Ltda. Analyses supplied by courtesy of S. C. Johnson & Son Inc., except as otherwise indicated.
[b] Determined at the Southern Regional Research Laboratory, U. S. Department of Agriculture, New Orleans, La.
[c] Drop point method. Cryoscopic melting point 79.7°C.

[2] This product contained 3% total impurities but no water; all other samples mentioned were also free of water, contained 1% or less impurities, and melted at 84.5-85°C. Yields of crude wax powder were higher than the figures quoted for the clarified wax.

On the basis of the usual laboratory tests it is apparent that it would be difficult to distinguish caranday from carnaúba wax. One firm reported that "in certain of the practical tests for finished polish product applications it shows up as well as carnaúba wax but in others it is somewhat inferior. In all of the polish product tests which were run however it was considered superior to ouricury wax."

Occurrence and Distribution of the Caranday Palm. In order to determine the distribution and density of the caranday palm in the Paraguayan Chaco several aerial surveys were made in Paraguay of the areas in which this palm is known to occur. Flights were made parallel to the Río Paraguay from Asunción to the Bolivian border and in a series of zigzag flights from the river into the Chaco for a maximum distance of about 65 miles. Another survey was made between the Río Pilcomayo and the Río Verde westward from the Río Paraguay to the 60th meridian. Other flights were made along the east side of the Río Paraguay from Lake Ipoá to the Río Apa and northward into Mato Grosso, Brazil, to the confluence of the Río Negro, thence along the west bank of the Río Negro to the Bolivian border.

These surveys revealed that the caranday palm occurs over an area of several thousand square miles of the Paraguayan Chaco and extends north and northeastward into Bolivia and Brazil. In the lower Chaco along the Río Paraguay and its tributaries the caranday varies from thick stands, to highly scattered, to none at all. In general, it occurs in palmars (grass-palm plains), varying in extent from a few hundred acres to many square miles. Within some of the palmars may be seen forested areas (monte duro), which when viewed from the air appear like dark islands (Figure 3). Farther north the palmars give way to

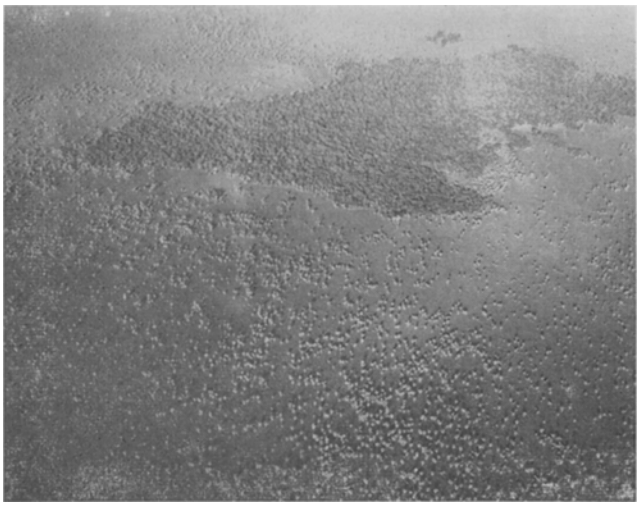

FIG. 3. Aerial view of a typical caranday palmar of the Chaco surrounding a hardwood forest.

bushland (monte), which is characterized by a dense growth of thorny shrubs and cacti, interspersed with hardwoods and devoid of palms except in the vicinity of the rivers and other drainage channels (Figure 4). In the northeastern section of the Paraguayan Chaco above Bahia Negra, and extending into Bolivia and Brazil, the caranday occurs in solid stands hundreds of square miles in extent.

FIG. 4. Aerial view in the Paraguayan Chaco of forest and bushland (dark areas) and caranday palms (lighter areas) along meandering river.

In general, the caranday palm is found throughout the Chaco wherever the land is subject to periodic flooding followed by complete drainage through runoff, seepage into the subsoil, or evaporation, and later to a protracted period of drying and parching of the surface layer of the soil. The palm is not found in areas above the flood level or in areas where submersion by water is more or less continuous. With the gradual raising of the alluvial plain through the erosion and redeposition of eastern slopes of the Andes and the highlands to the north and east of the Chaco, the forest and bushland takes over and the caranday palm disappears. The transition of the flora with slightly increasing elevation is illustrated in Figure 5. In the center of the photograph may be seen the water still remaining in the shrinking estero (swamp) as the dry season progresses. On either side may be seen the grass which appears as the estero recedes. Beyond and on either side of the treeless grassland are the caranday palms containing patches or islands of true forests (dark areas), which are above the flood level of the estero.

FIG. 5. Aerial view in the Chaco of changing flora with increasing elevation and drainage of the land. Center, receding swamp flanked by treeless grassland which in turn is succeeded by palmar (light areas) containing islands of hardwood (dark areas).

Exploitation of the Caranday for Wax. Based on the accumulated information and the results of the survey and investigations reported here, it would appear that the exploitation of the caranday palm for wax should be technically feasible. Many of the largest stands of this palm are adjacent to the Río Paraguay, on which regular boat service is maintained and along which are situated towns and industrial plants. Roads, trails, and narrow gauge railroads extend from the river into the Chaco at various points, thus making it possible to reach vast numbers of palms without difficulty.

The relatively smaller height and higher density of the caranday palm as compared to the carnaúba palm should make the collection of the leaves relatively easy.

The problem of labor supply, especially for harvesting the leaves, is probably the greatest handicap to be overcome in developing a caranday wax industry. Such skilled workers, administrators, and technically trained individuals as are located in the towns along the Río Paraguay are generally employed by the quebracho processing plants. This is generally true of a large number of Indians who live in the bush and are engaged in cutting quebracho. Cutting and processing quebracho for tannin is a year-round operation and probably considerably more profitable than would be the production of caranday wax; consequently it is unlikely that labor would be diverted from this source for cutting and processing caranday leaves. There are also many Indians employed on the ranches who may or may not be available at times for harvesting palm leaves.

It may be possible to induce additional Indians from the interior to migrate, at least for the leaf-harvesting season, to the vicinity of the palm areas. Since many Indians have been trained to be excellent *hacheros* (axe-men), it should be possible to train others to be equally good palm *cortadores*.

An item of very considerable importance to the establishment of a new industry is the attitude of the government with respect to taxation, export duties, rates of exchange, and the amount and degree of regulation which may be imposed on it, especially during its developmental stages. Given favorable governmental consideration and with the development of an adequate supply of efficient labor, the exploitation of the caranday palm could in time equal or surpass the carnaúba industry. This new source of hard vegetable wax would remove the threat of a shortage of this product for many years to come.

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A Survey of Institutions Which Offer Training in Fat and Oil Technology in the United States

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THE present survey of colleges and universities which offer training in fat and oil technology was compiled from replies to a letter of inquiry to members of the American Oil Chemists' Society[1] who are connected with these institutions. Additional names were obtained from a search of the current copies of the Journal for published articles which originated in college or university laboratories. Thirty-nine institutions were contacted and, on the basis of the data obtained, were divided into three groups. Those in group one offered no exclusive training or courses in fat and oil technology or did not reply. It was assumed that the latter group did not reply because they had no facilities or training available in this field. Those in group two offered specialized training in some aspect of fat and oil technology. Furthermore, research workers at these institutions have developed a phase of the field for which there may be no adequate substitute at another institution. However these institutions offered no course of study devoted exclusively to, or research involving broad phases of fat and oil technology. On the other hand, the institutions in group three all offered a specialized course or courses devoted exclusively to fat and oil technology and had a research program which involved both the chemical and biochemical aspects of fat and oil technology.

The basic undergraduate training at all of the 39 institutions surveyed, whether on a quarter or semester system, included one full year of general, quantitative, organic, and physical chemistry, and a year of physics and calculus. In most cases a course in biochemistry and bacteriology and a year of French and German were also required. A course in instrumental analysis, chemical literature, botany, zoology, political science, or economics was usually taken as an elective.

The first group was comprised of 22 institutions which offered no exclusive training in fat and oil technology (Table 1). However these institutions are important to fat and oil technology for two reasons. One, basic training in chemistry was available at all of them, and students graduating from these schools could serve as laboratory workers in industrial laboratories or as a source of graduate students. Two, at least one staff member of these 22 institutions is a member of the American Oil Chemists' Society or has published a paper in the Journal, indicating that

[1] Directory of Members, The American Oil Chemists' Society, July 1952.