CHEMICAL STUDIES ON COCONUT PRODUCTS.

II. UTILIZATION OF THE COCONUT.*

COCONUT, which in 1906 for a second time became nationally important to the Philippines, is now the country's second greatest export. According to the Bureau of Commerce and Industry, the yearly production of copra in the Philippines for the last ten years has been around 350 million kilograms; the value of the exported oil, copra, cake, and desiccated coconut for 1925 was P76,580,957 or about 27 per cent. of our total exports. Figures from the Statistical Bulletin of the Philippine Islands show that the Philippines furnishes about one-third of the world's supply of copra. Efforts are being made in some countries to bar coconut oil from the market that some other oils may be favoured; the final outcome will depend upon the cheapness of production of coconut oil. And the cost of production will depend not only upon proper fertilizing of the plantations, sound farm management, and marketing, but also upon the extent to which the waste products of coconut may be utilized.

The object of this paper is to review briefly the uses which the Filipinos and the industries have found for the different parts of the coconut plant, and to point out a few studies that could be made regarding some of its products.

Of the different parts of the coconut palm, namely, the roots, trunk wood, leaves, and nuts and flower spathe, hardly anything will be wasted under proper management.

THE ROOT, TRUNK AND LEAVES.

The roots contain tannin, and according to Sampson (1923) have been used as an astringent. The wood, if old and seasoned by soaking in salt water for about a month, may be used as posts, flooring, and rafters for houses; if well polished, it will serve as material for cabinet work and canes. The waste wood may be used for fuel, to make feeding troughs for pigs, and floats for fishing nets. The leaves if taken green can be used as material for screens and partitions, windows, mats, and baskets, as well as for raincapes and hats. The young leaves, called *palaspas,* are used for wrapping rice cakes called *suman.* The midribs may be used to make brooms and baskets. The young petiole may be used for tieing purposes. From the fibrous stipule, brushes and hats and native raincapes may be made; it can be used also as substitute for horsehair for stiffening clothing and furniture (Sampson, 1923). The fibres in the inner spathe are used in place of rope for tieing fences; this rope stands the weather as well as any other.

In case the coconut plant is found unproductive or is attacked by some disease, it may be cut done and the young stem tissues, the cabbage, may be used for food as a salad. The leaves, when burned, yield an ash rich in soda potash and phosphoric acid which may be used for making soap, or as a constituent of fertilisers.

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THE NUT.

Of all the parts of the coconut, the nuts give the most income. From these come the meat, the water, the shell, and the husk. The meat may be taken fresh from the nuts and, when cleaned and shredded and thoroughly dried under partial vacuum, the product is sold as desiccated coconut; this is widely used as an ingredient in puddings, cakes, pastries, and candies.

Locally, the fresh meat is grated and pressed with hot water to give a thick emulsion called *gata*. This is used much the same as cow's milk in making various desserts; it is also heated and the oil separated, leaving a nitrogenous residue, *latek*. Both the oil and latek are used for food.

The meat and water of the young coconut, known as the *buko*, are widely used on warm days, in much the same way as ice cream or cooling drinks. In localities where the source of water is not well known or considered sanitary, travellers rely wholly upon the water of the young coconut. Furthermore, it has been observed that young coconut water is a good diuretic.

When grated meat is dried with sugar the product is commonly known as *bukayo*, a sweet very much in demand among the Filipinos.

The bulk, however, of fresh meat is first treated to produce the copra which is later pressed for oil. This is the method used to prepare oil on a commercial scale. The oil may be used directly in the manufacture of soap and candles. The crude oil is sometimes used by Filipinos for illuminating purposes. Soaps prepared exclusively from pure coconut oil were shown by Walker (1926) to be very effective disinfectants against typhoid bacilli, paratyphoid bacilli, and dysentry bacilli. The stability of pure coconut oil makes it a good ingredient in the manufacture of many toilet preparations, such as creams and pomades. Experiments on the rate of hydrolysis of coconut oil, carried out in the Chemistry Laboratory in this College show that when placed in a glass container, pure coconut oil hydrolyses to only a very slight extent.

Table 1.

Showing rate of hydrolysis of pure coconut oil.

Amount of water mixed with the oil	Oleic acid at the beginning		Oleic acid at the end of 4 months		Rancidity.
	Covered	Uncovered	Covered	Uncovered	
per cent.	per cent.	per cent.	per cent.	per cent.	
37·61	·15	·15	·44	·44	Negative
38·71	·15	·15	·60	·45	,,
23·11	·15	·15	·60	·45	,,
16·81	·15	·15	·45	·60	,,
10·00	·23	·23	·46	·53	,,
3·96	·23	·23	·46	·46	,,
·11	·23	·23	·31	·31	,,

From table 1 it is evident that pure or refined coconut oil may be used in the manufacture of vegetable lard, oleomargarine and ointment; in fact, stable emulsions, such as mayonnaise, etc., have been prepared by Ayre (1923) from refined coconut oil.

Coconut oil has been shown by Cohn (1924) to be an adulterant of cacao butter, and Southcombe and Wells (1920) have shown that it can be used as an adulterant in lubricants. It has been recommended by Spiers

and Bitte (1926) as a constituent in the preparation of a mixture for oiling scoured wool. Keghel (1913) found it very useful as a constituent of a solution for the industrial preservation of eggs. Artificial petroleum which has been prepared from soybean oil and fish oil has been prepared by Kobayashi (1921) from coconut oil by heating the oil with Japanese acid clay. It has, furthermore, been found by Rivera (1925) that coconut oil has a slight curative effect on leprosy. When the oil is subjected to distillation with one to two per cent. sulphuric acid, the fatty acids and the glycerol are separated. Clycerol can be obtained also as a by-product in the manufacture of soap.

COPRA CAKE.

The residue, after pressing the copra for oil, is called copra meal or copra cake. It contains about 10 per cent. of oil and 17-18 per cent. of protein. Copra cake is generally used as cattle and chicken feed. According to Lindsey (1914) its nutritive value is equal to that of gluten feed, and if given in sufficient amount to cows it helps in producing butter which is firm in texture; further-more, Ewing and Spence (1918) found that butter from copra cake-fed cows has a high fat content. In the East Indies, copra meal has been suggested by Jansen (1921) as a useful protein for man when food is scarce. A combination of copra meal and rice bran has been shown by Allas (1924) to be a good supplement to camote vines for feed for growing pigs. However, Sulit (1926) found that if the cake is given in great amounts to rats it acts as poison.

Copra cake is valuable also a fertilizer. Jaojoco (1923) found that the cake contains 19·89 per cent. P_2O_5 and 8·14 per cent. K_2O.

COCONUT WATER.

The water of the coconut may be used for making fermented beverages, the Filipinos mix the water with corn starch and make vinegar. According to Leonard (1925) coconut water which has been allowed to ferment for four to five days will coagulate rubber latex and produce a rubber of good colour and purity.

COCONUT SHELL AND HUSK.

Various uses are made of the shell of the coconut. It is often made into bowls for ornamental purposes, into household utensils, carved articles, rubber-tapping cups and stringed instruments. According to the patent of Schwinger (1915) the shell may be used in the manufacture of colored buttons, and the shavings of the shell used for polishing hard colored articles. It is used also in the manufacture of corks. The shell is a good fuel, either as charcoal or untreated. The charcoal when properly prepared is extensively used in the refining of sugar, decolorizing of colored liquids, etc., and as an ingredient in the chemical purifiers in gas masks. It has been used by Shober (1910) as an absorbent in radium therapy. Coconut shell charcoal also serves as a catalyst in the production of alcohols and aldehydes from gaseous hydrocarbons. Kloppenburg (1924) synthesized methyl alcohol and formaldehyde from methane by oxidizing the hydrocarbon in the presence of coconut charcoal.

When a mixture of shell and coconut husk is subjected to distillation, an acid liquid is distilled. The distillate has been found by Stevens (1921) to coagulate rubber. When the shell or the husk is burned, it produces an ash rich in soda, potash, and phosphoric acid. Hence, the ash may serve as a source of alkali in the manufacture of soap or as a constituent of fertilisers.

From the husk, coir fibres that can be used in the manufacture of rope, twine, matting, rugs, and carpet and also for brushes and brooms and mops may be made. It has been calculated by Holonesky (1920) that from 1000 husks, 60 kilograms of spinnable fibre and 7·5 to 12·5 kilograms of stuffing fibre may be obtained. The spinnable fibre can be used, according to Von Uffel (1919), in manufacturing fire-proof roofing. There are a number of uses for the coir fibre. It is used in the place of hemp in the manufacture of rope and twine. Cordage made from the coir stands exposure to weather and water better than that made from some other fibres. The coir is also used for making door mats and floor mops. According to Sampson (1923), coir fibre is even made into belting for driving machinery. The stuffing fibres may be used in the manufacture of corks. The possibility of using coconut fibre as a raw material for some classes of paper or paper pulp has been suggested by Richmond (1906). The fibres also serve as a good fuel and for stopping of leakage.

THE FLOWER SPATHE.

In many localities the coconut is raised not for the nuts but for the flower spathe. This, on being cut properly, yields toddy which may be used as a beverage, either fresh or fermented, or it may be made into syrup, palm sugar, or vinegar.

SUMMARY.

The coconut products which are very much in demand at the present time are oil, copra, copra cake, and desiccated coconut. During the world war, coconut charcoal was extensively utilized in making gas masks, and with proper preparation it may be used for refining sugar. The sap from the spathe is extensively used in making fermented beverages. In passing, it may be pointed out that at the present price of the fermented drink in the Philippines, it is more than twice as profitable to cultivate the coconut for the toddy than for the copra. Coconut coir is used in the manufacture of cordage and upholstering.

It would be interesting to find out whether the system practised in the sugar centrals as applied to sugar production cannot be applied in coconut plantations. Conditions under which copra is handled make the price of the oil relatively much higher than if it were obtained directly from the fresh nuts. These conditions are; under the present method of handling copra for export a large percentage of the oil is lost in transit owing to the action of moulds; the inconvenience of handling copra because of the impurities, such as sand, nails, etc., deliberately thrown in by the middlemen; and that, in order to get high grade oil, refining is necessary. The main difficulty in obtaining the oil from fresh coconut meat seems to be the lack of knowledge about the method of separating the protein colloids from the oil.

Other important investigations that my be carried out with profit are the utilization of copra cake for fertilizer and food, and the manufacture of charcoal for sugar refining from coconut shell.