CLXIV. THE CHEMISTRY OF THE PRODUCTS OF *COCOS NUCIFERA*. PART I.

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IN this series it is proposed to study the chemistry of the various products of the coconut palm, especially those of economic value. In the present communication the kernel and the oil at various stages of development of the nut have been examined, as also the constituents of the haustorium.

The development of the fruit has been studied in some detail by botanists and an account of it is given by Sampson [1923]. On the chemical side Sampson (pp. 72-73) reports results regarding the quantity of kernel, oil, etc., found in the fruit at various stages but no investigation has hitherto been carried out on the nature of the oil obtained.

As regards the development of the fruit, it has been found that it sets properly about 50 days after the flower has faded. It attains its full size in about 168 days when the "meat" just commences to form. When about 224 days old, the shell commences to harden and the "meat" forms all round the inside of the shell. This stage corresponds to bunches 4 and 5 in Table I. At the end of about 308 days the meat is fully formed although the shell has not completely hardened. This stage corresponds to bunch 3, Table I. The oil from one of these bunches ("Panadura") was found to have a very rancid smell, even when freshly prepared. At the end of a year from the complete setting of the fruit, the nut is ripe and the shell is fully hardened. The two bunches 1 and 2 correspond to this stage, the former being quite dry and ready to drop; the latter though not so dry is also ready for harvest.

Four or five bunches from each of four trees were examined, one from Colombo (Kitulwatta), the second from a suburb of Colombo (Dehiwala), the third and fourth from Moratuwa and Panadura, two coast towns 13 and 16 miles respectively south of Colombo. The Colombo tree belongs to a somewhat uncommon variety: each bunch contains 40 to 50 nuts which are about half the size of the common variety.

For extraction of the oil the nut was split transversely, scraped by means of a domestic coconut scraper, dried to constant weight at 50-60° in an electric oven and the dried material was extracted in a Soxhlet extractor with light petroleum (b.p. 40-60°). Anhydrous sodium sulphate was placed in the flask during the extraction to ensure complete drying. The extract was filtered and

after distillation of the solvent on the water-bath the last traces were removed by passing dry air through the oil for about 12 hours first on the water-bath and finally at room temperature.

A large number of the remaining Kitulwatta nuts of bunches 1 and 2 were left in the soil to germinate. The stages of development of the embryo are well known. "The germ commences to grow in two directions—the plumule or shoot grows towards the 'soft eye' of the shell and the other end of the germ develops an absorbent growth or haustorium, 'coconut apple,' towards the central cavity of the seed" [Sampson, 1923]. The haustorium is yellowish on the surface but white inside with fibres running longitudinally. It was cut into small pieces which were treated in two ways, (1) dried at 50–60°, the oil being extracted with light petroleum (b.p. 40–60°) and the carbohydrates with alcohol, (2) pressed, the juice being extracted with light petroleum and the residual solution evaporated. The isolation of the sugars has not yet been carried out.

Table I.

Sample Kitulwatta	Kernel			Oil		Residue				
	Water %	Oil %	Resi- due	Sp. gr.	R.I.	Acid value	Sap. value	Iodine value	Ash %	Pento- sane %
Bunch 1	36.4	40.4	26.7	0.9172	1.4551	0.66	236.9	7.29	4.30	2.38
" 2	48.1	40.0	18.7	0.9152	1.4559	0.42	234.1	6.84	5.87	2.89
" 3	38.2	43.2	23.3	0.9172	1.4543	0.38	245.0	7.32	5.06	2.48
" 4	60.8	21.6	16.7	0.9207	1.4532	0.74	260.4	7.44	5.45	2.49
" 5	83.2	4.6	10.9	0.9290	1.4564	1.23	245.2	12.94	6.96	2.40
Dehiwala										
Bunch 1	42.0	36.7	21.4	0.9374	1.4539	0.93	267.7	5.07	5.57	1.93
" 2	45.5	36.0	20.0	0.9297	1.4538	0.73	268.4	3.37	5.79	1.96
" 3	46.0	35.5	22.5	0.9271	1.4538	0.80	278.2	5.86	10.65	1.88
" 4	46.7	6.7	—	0.9199	1.4560	2.35	257.2	8.29	—	—
Moratuwa										
Bunch 1	41.4	40.9	22.7	0.9158	1.4500	0.24	265.4	5.73	5.48	2.07
" 2	42.1	38.5	20.7	0.9190	1.4540	0.23	260.3	6.48	4.86	1.91
" 3	44.3	39.0	19.6	0.9132	1.4534	0.53	264.0	5.89	5.35	2.22
" 4	47.2	33.4	18.8	0.9188	1.4536	0.36	260.0	5.62	6.54	2.02
Panadura										
Bunch 1	41.7	39.8	20.0	0.9182	1.4550	0.23	253.1	6.74	6.57	2.71
" 2	42.0	42.7	20.8	0.9170	1.4550	0.12	249.8	5.78	6.19	2.10
" 3	43.8	38.5	20.0	0.9170	1.4560	0.36	257.1	6.43	6.12	2.10
" 4	49.0	31.3	20.5	0.9184	1.4548	0.53	251.7	5.63	6.11	2.10
" 5	59.4	25.4	22.2	0.9192	1.4550	0.53	255.1	6.70	6.17	2.11

The haustorium contained 84.9 % of moisture and the dried material yielded 18.9 % of an oil which had sp. gr. 0.9177 at 29°, saponification value 238.7, iodine value 16.1, acid value 1.46. The press juice of the fresh haustorium was an opaque liquid of sp. gr. 1.040 from which was extracted 0.62 % of an oil with sp. gr. 0.9171, saponification value 248.0, iodine value 10.1, and acid value 1.47.

The dry residual material after extraction of the oil contained pentosans 9.49 %, lignin 27.0 %, and ash 4.05 %.

DISCUSSION.

As was expected, the percentage of the water in the kernel diminishes with age. The oil content at the latest stage is either less than or equal to that at the preceding stage. The quantity of "residue," mainly cellulose, appears to vary only slightly during all the stages of development; in two of the sets, Panadura and Dehiwala, it is practically constant. The quantity of pentosans calculated on the dry material is nearly the same in all cases and is low, whereas in the haustorium it is comparatively high. Another point of interest is that the residue or "cake" is lignin-free, while the lignin content determined by the hydrolysis of the carbohydrates by means of 72 % sulphuric acid is very high. It is probable that pentosan formation precedes the conversion of cellulose into lignin.

As regards oil the constants do not seem to vary greatly except for the iodine and acid values which are high in the oil from the youngest bunch. It is also noteworthy that the oil from the haustorium has an even higher iodine value.

REFERENCE.

Sampson (1923). The coconut palm.