

THE SEED FAT OF GARCINIA ECHINOCARPA,  
THWAITES<sup>(1)</sup>—"MADOL OIL"

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IN 1900 among the exhibits sent from Ceylon to the Exhibition at Paris was a small collection of oils from forest trees and uncultivated plants. A brief description of these oils was published in *The Tropical Agriculturist* (Ceylon), Vol. XX., No. 9 (March, 1901) *Suppl.* p. 650 and No. 10 (April, 1901) *Suppl.* pp. 728-9; and these notes were reproduced in the *Journal\* of the Imperial Institute*, June, 1901, and in the abstracts of the *Journal of the Society of Chemical Industry*, 1901, 20, 641.

"Madol Oil" was one of the oils included and all later references thereto in standard works such as those of Lewkowitsch (2) and of Grün & Halden (3) are derived from the 1901 description mentioned above. It is described as "the product of *Garcinia echinocarpa* (Guttiferæ)—a tall tree of the forests in the lower mountain zone of Ceylon. The thick oil is extracted from the seeds. Thwaites mentions that it is burnt but it yields a poor light. The leaves and bark are used in dropsical affections, and also as a vermifuge: no mention is, however, made of the oil being medicinally employed". Alston (4) states that *G. echinocarpa* also occurs in S. India.

We have recently had the opportunity of examining a sample of the seeds and the expressed fat. The fruits of *G. echinocarpa* usually contain one, two or (less commonly) three seeds, which are described by Trimen (*loc. cit.*) as "1 in., subglobular or ovoid, testa thick, reddish brown". Our sample of seeds averaged 2.52 (longest diam.) and 2.05 (shortest diam.) cm., the range being 1.8 by 1.5 cm. to 3.2 by 2.4 cm. They were all ovoid (the nearest to spherical being 2.2 by 2.1 cm.), except that those from two-seeded fruits were compressed on one side, and the few from three-seeded fruits had two sides somewhat compressed.

The sample (No. 1) of expressed fat with which we were supplied under the name "Madol Oil" was a chocolate-coloured fat, somewhat granular in appearance, with a characteristic aromatic odour.

\*Not the *Bulletin*, as erroneously stated in Grün and Halden (*loc. cit.*); this only commenced publication in 1903.

The coats of the seeds were removed, the kernels dried, ground and extracted with light petroleum, b.p. 40–60° :

Average weight of 100 seed-coats : 72 gms. (23 per cent. of whole seeds)  
 Average weight of 100 kernels : 240 gms. (77 per cent. of whole seeds)  
 Average weight of 100 seeds : 312 gms.

|                              |    |    |      |
|------------------------------|----|----|------|
| Kernels : Moisture per cent. | .. | .. | 7.9  |
| Oil per cent.                | .. | .. | 64.4 |
| Oil per cent. (dry basis)    | .. | .. | 69.9 |
| Oil per cent. on whole seeds | .. | .. | 49.6 |

The extracted oil (referred to as sample 2) was deep brown and viscous, slowly solidifying at about 26°C to a soft yellowish brown fat, which re-melts at about 37°C. It has a not unpleasant characteristic odour. The usual constants were as follows :—

|                                   | Sample 1. | Sample 2.      |
|-----------------------------------|-----------|----------------|
| Density $d_{15.5}^{99}$           | .. 0.878  | .. 0.877       |
| Refractive Index $n_D^{40}$       | .. 1.4688 | .. 1.4690      |
| Dispersive power                  | .. —      | .. .0183       |
| Melting point (Capillary tube)    | .. —      | .. 36.5—38.5°C |
| Free fatty acid (Oleic per cent.) | .. —      | .. 7.0         |
| Saponification value              | .. 202.4  | .. 203.4       |
| Iodine value                      | .. 72.5   | .. 73.0        |
| Titre (fatty acids)               | .. —      | .. 55°C        |

*Constituent Fatty Acids of Fat.*—A preliminary examination of the fatty acids showed stearic and oleic acids to be the major components. Separation by crystallization of the lead salts from alcohol gave 40.5 per cent. of “solid” acids (Iodine value 3.8; Saponification equivalent 282.2) and 59.5 per cent. of “liquid” acids (Iodine value 110.5; Saponification equivalent 311.2).

Crystallization of the “solid” acids from alcohol readily gave almost pure stearic acid (m. p. 69°C) in over 70 per cent. yield. Their composition may therefore be reasonably calculated from the iodine value and saponification equivalent as oleic 1.7, palmitic 3.0 and stearic acid 35.8 per cent. of the total acids.

The “liquid” acids contain a considerable amount of resinous acidic material insoluble in light petroleum, and also of unsaponifiable matter. When freed from these, they had Iodine value 92.9, and oxidation by Lapworth’s method (5) gave dihydroxystearic acid in amounts indicating the presence of at least 41.4 per cent. of oleic acid (as percentage of total acids).

The fatty acids of madol fat may therefore be taken as containing at least 36 per cent. of stearic and 43 per cent. of oleic acid, with minor quantities of palmitic and linoleic acids.

Vegetable fats which are largely made up of stearic and oleic acids are mostly confined to the Natural Orders *Guttiferæ* and *Sapotaceæ*. Of *Garcinia* spp., Hilditch (6) gives references for *G. cambogia*, *G. indica* and *G. morella*.

We regret that we have not the opportunity at the present time to undertake a more detailed investigation of this typical member of an interesting group of fats.

*Potential Economic value of Fat.*—The kernels appear to contain phenolic substances which darken rapidly when the surface of the kernel is exposed. This probably accounts for the dark colour of the oil. In any case, on account of its acidity, colour and odour, the oil would require considerable refining before it could find any industrial application.

The crushing of the kernels would not present any great difficulty, as their moisture and oil content is similar to that of copra, and they could well be crushed in an expeller. The decortication of the seeds on a large scale would, however, be troublesome, and it might be necessary to crush the whole seeds, with consequent reduction of oil yield.

A yield of 60–61 per cent. of oil on the crushed decorticated kernels could be obtained in practice, or rather under 40 per cent. on the whole seeds.

The fat is not likely to be utilizable for edible purposes, owing to the extensive refining required.

Owing to its exceptionally high titre (55·0°C) it might be useful in soap-making, especially in Ceylon where the principal soap-making oil is coconut, which has a low titre.

Another possibility is the preparation of “stearine” for candle making. Thus, a sample of the mixed fatty acids gave after one cold pressing in a Carver laboratory press, 44 per cent. of a “stearine” of Iodine Value 18·4. This was very dark in colour, but could be bleached by acid dichromate solution.

The refining of the fat needs particular study, and it could not in any case be successfully exploited commercially unless available in quantity at a very cheap cost of collection.

*Extracted kernels.*—The dry oil-free extracted kernels had :

|                     |   |                |
|---------------------|---|----------------|
| Nitrogen (Kjeldahl) | = | 1·57 per cent. |
| Ash                 | = | 8·46 per cent. |

The ash contained :—

|                               |    |    |    |                |
|-------------------------------|----|----|----|----------------|
| K <sub>2</sub> O              | .. | .. | .. | 39·7 per cent. |
| CaO                           | .. | .. | .. | 15·6 „ „       |
| MgO                           | .. | .. | .. | 13·5 „ „       |
| Na <sub>2</sub> O             | .. | .. | .. | 1·5 „ „        |
| P <sub>2</sub> O <sub>5</sub> | .. | .. | .. | 5·0 „ „        |
| SiO                           | .. | .. | .. | 0·2 „ „        |

The residual cake has therefore very little manurial value, except for about 3 per cent. of potash.

## SUMMARY

The kernels of *Garcinia echinocarpa* (Sinh. Madol) contain about 64 per cent. of a solid fat. The seed fat, in common with other seed fats of *Garcinia* spp. and the *Guttiferæ* generally, contains notable proportions of stearic and oleic acids. It might be applicable in soap making and in the preparation of "stearine". As obtained from the seeds it is, however, acid, dark in colour and of pronounced odour; and would need extensive refining. Its commercial exploitation would therefore be doubtful unless the seed could be collected in quantity at a very cheap rate.

## REFERENCES

1. Thwaites. *Kew Journ. Bot.* 1854. vi. 71. Fl. B. Ind. i. 264.  
See Trimen: *Flora of Ceylon*, Vol. I, 1893, page 96.
2. *Chemical Technology & Analysis of Oils, Fats and Waxes*, 6th edition, 1922, Vol. 2, p. 611.
3. *Analyse der Fette und Wachse*, 1929, Vol. II., p. 673.
4. Alston in Trimen's *Flora of Ceylon*, Vol. VI., 1930, p. 86.
5. Lapworth, A. and Mottram, E. N.—*J. Chem. Soc.*, 1925, 127, 1629.
6. Hilditch, T. P.—*The Chemical Constitution of Natural Fats* (1940), page 155.