lenic acid is absent, *i.e.*, for the case 1(A), previously described, provided that in all determinations the point A and the scale AA', corresponding to 0% linolenic acid, is used in drawing the lines.

In Tables I, II, and III are given the calculated and observed values as read from the charts. The differences observed between the observed and calculated values are to be ascribed entirely to the limitations of manual skill in the drawing of the alignment charts and its convenient magnification. With accurately drawn scale markings and suitable magnification of the scales it is possible to secure reading accuracy very nearly approaching the mathematical accuracy behind construction of the chart.

Summary

Very few alignment charts are available which can be used for routine calculations in fat analysis and processing. Three alignment charts are presented in this communication for determining the fatty acid composition of a fatty acid mixture consisting variously of linolenic, linoleic, oleic, and saturated fatty acids or glycerides, incorporating for accuracy, data based on ultraviolet extinction coefficients. In two of the charts triangular diagrams have been used as a novel feature in nomography to give directly the fatty acid composition.

REFERENCES

1. Brice, B. A., Swain, M. L., *et al.* J. Am. Oil Chemists' Soc., *29*, 279 (1952).
2. Hussain, S. A., and Dollear, F. G., *Ibid.*, *27*, 206 (1950).
3. Illarionov, V., and Torchinskii, M., Masloboino Zhiromoe Delo, *13*, No. 6, 23 (1937).
4. Kaufmann, H. P., and Keller, M. C., Fette u. Seifen, *51*, 223 (1944).
5. Suomalainen, H., and Archimo, E., Mitt. Lebensm. Hyg., *37*, 173 (1946).
6. Wan, C. S., and Ho, K., Ind. Eng. Chem., Anal. Ed., *8*, 282 (1936).

Several Rare and Uncatalogued Oils of Ecuador

ROZIER D. OILAR, Consultant for Latin America, 1213 North Street, West Lafayette, Indiana

ONLY about three countries of South America have an exporting supply of native vegetable oils. Most of them are importers to a greater or lesser extent. All types of oil-bearing seeds and nuts are used in many of the other countries, and many have indigenous oil seeds that would be classed as rare and are little known in our well supplied countries and are, in general, uncatalogued.

This is the situation in Ecuador, which has but scant quantities of the usual oil seeds and must extend its supply by any and all seeds and nuts that will yield oils and fats. So we shall describe some of these oils and their nuts and seeds, adding a few which, although described by Jamieson *et al.*, are not commonly known but are of great importance.

In Manta, state of Manibi, Ecuador, in a new oil mill and refinery we produced oils from nuts and seeds of the following indigenous trees and plants, with their local name, family, and genera in that order:

Brazilargo of *Myristicaceae* family, genera not given, is a tree producing a roundish, slightly oval, thin-shelled seed with a kernel 1.5 by 2.5 cm. in size, its cross-section of white meats are speckled with brownish, chocolate-colored spots. There is a limited supply of this tree and nuts. The kernel contains some 60% of a very dark to blackish crude fat in its melted form, yellowish brown when solidified. On filtering, the color is more reddish brown and brownish yellow, respectively. It has a toasted flavor. The press room samples of crude have F.F.A. of 14 to 15% as oleic or 10% as lauric acid. The oil has a melting point (M.P.) of 46 to 47°C.

Caracolillo (Carcoli) of *Anacardiaceae* family and *Anacardium excelsum* genera, is a tree bearing a fruit with a seed that has a kernel 1 by 1.5 cm. in size, the cross-section of whose white meats is striated with chocolate color stripes. The kernels contain some 50% fat of reddish brown color in the melted form and yellowish brown in solidified form, quite similar to the Brazilargo oil. The Expeller sample tested F.F.A. of 11% as oleic, or 7.7% as lauric acid. The M.P. of fat is 47 to 48°C.

Chapil (Deopa) of *Palmae* family, genera not given, is a tree with a fruit similar to the Palm Real containing one edible coquito-like nut and is not very plentiful. It is known mainly for its wood. Few other data are available. The seed yields a liquid type of oil (only a slight amount of stearine at 18°C.), crude color around 25Y/20R Lovibond scale, with an agreeable flavor. The press room sample tests F.F.A. of 9.5% oleic acid. It is said the leaves of this tree carry a wool or fiber used by the natives for gun wads.

Guangara of *Myristicaceae* family and *Dial-yanthera gordoniaefolia* genera, is a tree, producing a roundish, thin-shelled brown nut 2 by 2.5 cm. in size, weight 3 gms., somewhat similar to the nutmeg. The cross-section shows light chocolate-colored meats. The nuts produce some 40% fat of dark brown color when melted and pale brownish yellow when solidified and refines to an unusual pinkish red oil or pinkish color when solidified. The Expeller samples test F.F.A. of 16% as oleic or 11% as lauric acid. The fat has a M.P. of 43 to 44°C.

There is some confusion as to the international botanical classification of Tangare (Figuarae) of *Meliaceae* family, *Carapa guianensis* genera, which is very probably the Andirobe of Brazil, listed by Jamieson as *C. tulucuna*. It is a tree whose seeds are 75% kernel with a solid, light chocolate-color cross-section, which, on drying, shrivel to an odd flattened shape like large candied figs and measure 3 by 5 cm., weigh up to 15 gm., yielding some 45% inedible fat of reddish color when melted and pale brown when solidified, with a bitter flavor. The F.F.A. from the press room is very high, 30-40%, and higher as oleic acid, but samples were not usually straight Tangare as the seed is usually mixed with meal of other seed for better pressing. The F.F.A. of a filtered sample was 51% as oleic or 36% as lauric acid. The fat has a M.P. of 38-39°C. Book data gives Saponification No. 198 to 200, Iodine No. 58 to 75, and Titre of Fatty Acids 35 to 37°C. (1).

Tagua (Cady) of *Palmae* family and *Pytelephas macrocarpa* genera (some say *P. acquatorialis*) is an unusual palm for its products. This tree bears a very large fruit, 25 by 40 cm. (10 by 15 inches) in size, which contains several large seeds enclosed in a pulp which, when dried like copra, is a pale brownish color and yields 35 to 38% semi-liquid type of edible oil. This crude oil is reddish yellow when melted and light golden yellow in solid form, is heavily stearinated at 20°C. but entirely melted at 29 to 30°C., and is quite similar to a high stearine natural cottonseed oil. It refines to around 35Y/7.6R on Lovibond scale and bleaches to 20Y/2.5R slightly greenish color. The flavor is normal, slightly bitter in the crude form. The F.F.A. from the press room tests 10 to 12% up to 20 to 30% as oleic acid and has a Sap. No. of 202 (2). This appears to be the first commercial production of Tagua oil since this tree is known for its seed or nuts which, when young and tender, are used as food but on maturity become the very hard Vegetable Ivory of commerce and are sold the world over for making buttons, novelties, marbles, and even billiard balls. These nuts are an important export article of Ecuador.

Palma Real of *Palmae* family and *Cocus butyriaceae* genera is not the Royal Palm *(roystonea regia)* or palm kernels *(elaes guincensis)* listed by Jamieson as *Ynesis colenda*. These nuts

are in large quantities and the chief supply of Ecuador and neighboring countries. They are 2.5 by 5 cm. in size with a hard 3-mm. shell. The kernels measure 1.5 by 2 cm. and weigh 3 to 4 gms. The white meats yield 48 to 50% of a coconut type of oil. The crude melted is about 35Y/12R color and refines to 20Y/2.5R color and bleaches to a near water-white color. Solidified colors are very pale yellow, cream, and white, respectively, with a decided coconut oil type of characteristic crystals. The F.F.A. of fresh nuts is as low as 0.5% as lauric but usually runs 5 to 6% as lauric acid. It has a Sap. No. of 250 to 253, Iodine No. of 15 to 16%, and M.P. around 24°C., all practically that of coconut oil, and its flavor is of coconut nature. This nut does not store or ship well due to its rapid increase in F.F.A., but its oil refines nicely and serves well for current quality compound with proper quantities of flakes and with or without other oils. The crude oil settles out a troublesome black sediment which can be caustic-washed to a white fat for soap.

Piñon of *Euphorbiaceae* family and *Jatropa curcus* genera, called Tortagos in Chile, is classed by Jamieson as the physic nut and is more toxic than castor bean. This plant is a bush and is very plentiful in Ecuador and other countries, is used for fences, etc. Each nut, 2 by 3 cm. in size, has three seeds 1 by 2 cm. in size with a thin blackish shell and 65 to 75% white meats. It yields some 38% (meats 50%) excellent liquid type of oil, usually with low F.F.A. of 2 to 3% as oleic acid. The crude oil is about 35Y/7.6R color, refining easily to around 20Y/2.5R color. However, ironically, its high refined colors avail naught as it can be used only for soap. It has a Sap. No. of 189 to 193, Iodine No. 93 to 107, Titre of 27 to 29°C. (3). This oil deposits no stearine at 15°C. and lower.

Ceiba (Kapoc) of *Bombacaceae* family and *Bombax ceiba* genera, is a large-spreading, fluted or lobed trunk tree and produces the Kapoc pod with its fine silk floss and small round seed containing 20 to 25% fine liquid type of oil similar to and interchangeable with cottonseed oil, with which family it is related. It is in considerable numbers in Ecuador, but its seed crop is very dependent on the season's rainfall. The small brown seed measures 0.5 by 0.75 cm., small pea size (100 weigh 14 gms.), with 60% white meats and 40% oil. The crude oil is around 35Y/12R color and refines readily to around 20Y/3.0R. The flavor is normal. The crude F.F.A. is fairly low, however the press room samples usually mixed with cottonseed tests up to 6 to 8% as oleic acid. It has a Sap. No. 189 to 195, Iodine No. 86 to 100, and a Titre (F.A.) 27 to 32°C. The silk floss wool is attached to the husk of the elongated pod and not to the seed (like cottonseed) and is removed by air currents instead of gin saws, which would ruin the very delicate fibres. The Kapoc oil gives the characteristic Halphin Reaction (5) as does cottonseed and is the only other oil that responds to this positive color test (6).

MAY we now step out of Ecuador to point to some rare and little known oil seeds? Colombia has a dark yellow, 3 by 5 cm., heart-shaped edible Cachipay oil seed uncatalogued and as yet unexploited which is said to be in considerable quantities in the Cauca Valley.

Mexico has the Cachuanancha (7) of the *Rosaceae* family and *Licania arborea genera*, a fruit with a seed of 43% kernel, containing 69% oil according to Jamieson, which is quite similar to the oiticica, *Licania rigida* oil. This oil has an Iodine No. of 153 and a Sap. No. of 187, and contains 70% licanic acid while oiticica oil has but 8% more or 78% *Licanic* acid (8).

While in Barbados, B.W.I., we made a beautiful oil, attractive as a salad oil from lime seed imported from Grenada Island, which contains up to 40% of a beautiful, light-colored oil. It has an Iodine No. of 109, Sap. No. up to 197, and Titre (F.A.) of 34°C. (9), but it solidifies only at about 0°C. No doubt this was the first commercial production of the oil, which we shipped to Liverpool, England, unrefined at a premium over cottonseed oil due to its pronounced natural lime flavor for salads. The press cake however is too chaffy and fibrous for stock feed and has little value as a fertilizer.

REFERRING again to the special oils of Ecuador, which, due to poor storage for seed and unclarified crude oil, had such high F.F.A. ranging from 7 to 10% up to 15 to 20% as oleic and much higher from storage tanks, we report that they were not economical for refining. They did offer the advantage of the use of soda ash (carbonate) however in saponifying in the soap kettle up to their acid equivalent, thus aiding the economy in the soap plant.

A point of passing interest in reviewing these seeds and nuts of the Ecuadorian samples is that many of their kernels are marked from specks to solid coloration by a chocolate brown. Does this bear any relation in any way to the Cacao *(theobromo cacao)* chocolate bean, from which the chocolate color name originates and which tree is indigenous to this general terrain? Perhaps the bio-chemists can resolve this question.

Acknowledgment

We wish to acknowledge the assistance of the Departments of Forestry and Botany of Ecuador through former President Sr. Galo Plaza, Ing. Pedro Pinto Guzman, and the Industrias Ales C. E. for the scientific classification of their native trees (10).

REFERENCES

1. Jamieson, George S., "Vegetable Oils and Fats," 1943, p. 33, under Andirobe.
2. Life Laboratories, Quito, Ecuador.
3. Jamieson *et al.*, "Vegetable Oils and Fats," p. 224, under Curcas oil.
4. Jamieson, "Vegetable Oils and Fats," p. 84, under Kapok Oil.
5. Oilar, Rozier D., American Chemical Journal, *35*, Oct., 1900, p. 355.
6. Lewkowitsch, Chem. Technology and Analysis of Oils, Fats, and Waxes, 4th Ed., 1909, Vol. II, p. 163, Oilar footnote.
7. Oil & Soap, November, 1940.
8. Jamieson, "Vegetable Oils and Fats," p. 335.
9. *Ibid.*, p. 232.
10. Holdrige, Teesdale, Myer, *et al.*, "The Forests of Western and Central Ecuador," by Forest Service, U. S. Department of Agriculture, 1947, a reference by Gustavo Orcés, director, Biological Sciences, Ecuador.

[Received October 20, 1953]