[CONTRIBUTION FROM THE LABORATORY OF FOODS AND SANITATION, UNIVERSITY OF WISCONSIN]

Hazelnut (Filbert) Oil

BY H. A. SCHUETTE AND CHANG Y. CHANG

Data on the composition of the oil in the hazelnut, *Corylus avellana* L.—the cultivated variety is known as the filbert—are few and not in agreement. There appears to be unanimity of opinion[1a,d,e,f,k] as to the presence of palmitic and stearic acids but no agreement with respect to arachidic acid; in fact evidence to the contrary[1f,k] seems to outweigh that in support of it.[1a] There is, also, no question as to the presence of oleic acid. That another acid, of a higher degree of unsaturation than oleic, is probably present has been predicted[2] but never substantiated.[1f] Numerous reports[1] on its more common chemical and physical characteristics are available but none is comprehensive, and those which have been obtained in the examination of domestic oils[1g,h] are indeed few. No chromatic reaction which might serve in its qualitative identification has been discovered to date.

Approximately one-half by weight of the filbert consists of an edible portion whose oil content has been variously reported to lie between 60 and 66.4%. The oil itself finds an extremely limited use, if any at all, in this country. Published information on its utilization is practically restricted to foreign sources. It is therein revealed that, besides the obvious technical uses to which fatty oils may be put, hazelnut oil is prized in certain districts of Switzerland[1k] for its edible qualities; that the chocolate and confectionery industries furnish an outlet for some of it[1b]; and that it has been used to adulterate[3] almond oil. The suggestion[4] that it could worthily occupy a place in domestic economy next to that of olive oil is also of interest in this connection.

The fragmentary and incomplete nature of the data, and the desirability of confirming earlier statements as to its quantitative composition, seemed sufficient reason for undertaking a re-investigation of this oil. For this investigation about one-half of the oil in the nuts (kernels) was expressed with a laboratory press. The remainder was recovered by solvent extraction. Each fraction, referred to later as expressed and residual oil, respectively, was examined.

(1) (a) Schädler, Carl, "Die Technologie der Fette und Öle," Leipzig, **1883**, p. 477; (b) Filsinger, *Chem.-Ztg.*, **16**, 792 (1892), through *Chem. Zentr.*, II, 104 (1892); (c) Soltsien, *Pharm. Ztg.*, **38**, 480 (1893); (d) De Negris and Fabris, *Z. anal. Chem.*, **33**, 558 (1894); (e) Schöttler, *Apoth. Ztg.*, **11**, 533 (1896); (f) Hanus, *Z. Nahr. Genussm.*, **2**, 617 (1899); (g) Merrill, Maine Agric. Exper. Sta., *Bull.*, **65**, 111 (1900); (h) Pancoast and Graham, *Am. J. Pharm.*, **76**, 70 (1904); (i) Knorr, *Seifensieder Ztg.*, **39**, 523 (1912), through *Chem. Abstracts*, **6**, 2552 (1912); (j) Klimont, *Pharm. Post.* **51**, 561 (1918), through *Chem. Zentr.*, II, 735 (1918); (k) Pritzker and Jungkunz, *Z. Nahr. Genussm.*, **42**, 232 (1921).

(2) Tortelli and Ruggeri, cited by Lewkowitsch, "Chemical Technology and Analysis of Oils, Fats and Waxes," The Macmillan Co., London, 1921, 6 ed., Vol. II, p. 339.

(3) Bennett, *Chemist Druggist*, **72**, 89 (1908).

(4) Sava, *Staz. sper. agrar. ital.*, **55**, 34 (1922).

I. Preparation of Materials

Fresh filberts of Italian importation were used in this study. Petrolic ether extraction showed that the kernels contained 66.6% of oil. Approximately 51% of this amount was expressed in an hydraulic press (940 kg. per sq. cm.). The residual pulp was then extracted with low-boiling petroleum ether, the final portions of which were in turn removed from the oil by distillation under reduced pressure and in the presence of carbon dioxide. No refining treatment was necessary beyond filtration. The expressed oil was found to have a lemon-yellow color in contrast to the golden yellow of the other product. The flavor of the nut itself was more noticeable in the latter than in the former, but in either case the oil possessed a mild and agreeable taste.

II. Analysis of Oils

(a) **Chemical and Physical Characteristics.**—The more important chemical and physical characteristics (Table I) of both oils were determined by well established procedures.[5]

Except for the Reichert–Meissl number, which was found to be higher, it appears that the physical constants, the unsaponifiable matter and the iodine, saponification, acetyl, Hehner and Polenske numbers are of the order of magnitude reported by others.[1] The values found for saturated acids do not confirm those of Hanus (10.41%),[1f] but there is some measure of agreement with his data on the content of unsaturated acids (85%).

The low acidity, together with the fact that a sample of the expressed oil taken from a specimen bottle after one year neither showed a significant increase in acid number, nor yielded a positive Kreiss reaction[6] for rancidity, suggests the probable absence of any very active lipases in the nut. Glycerides of water-soluble acids are apparently present in amounts small enough to escape quantitative estimation within the limits of accuracy of the analytical method which was employed in their determination. This, however, is a point in need of confirmation.

TABLE I

CHEMICAL AND PHYSICAL CHARACTERISTICS OF HAZELNUT OIL

	Expressed oil	Residual oil
Specific gravity 20/20°	0.9144	0.9150
Index of refraction, 20°	1.4698	1.4700
Iodine number (Hanus)	84.70	85.48
Thiocyanogen number	82.09	81.37
Saponification number	191.12	190.19
Reichert–Meissl number	2.73	3.33
Polenske number	0.57	0.71
Free fatty acids (per cent. as oleic)	0.15	0.32
Acetyl number	2.65	3.24
Soluble acids (per cent. as butyric)	trace	0.02
Insoluble acids (Hehner number)	95.44	94.90
Saturated acids (per cent.) corrected	4.87	5.20
Unsaturated acids (per cent.) corrected	90.97	91.45
Thiocyanogen number of unsaturated acids	86.82	89.22
Iodine number of unsaturated acids (Hanus)	89.70	90.43
Saponification number of unsaturated acids	192.1	194.6
Unsaponifiable matter (per cent.)	0.55	0.50

(5) Association of Official Agricultural Chemists, "Methods of Analysis," Washington, D. C., 1930, 3d ed., pp. 314–330.

(6) Kerr, *Ind. Eng. Chem.*, **10**, 471 (1918).

(b) **Unsaturated Acids.**—The non-existence of linolenic acid in this oil was indicated by the formation of no ethyl ether-insoluble precipitate of hexabromide on the addition of bromine in the cold (−10°). Small quantities of the tetrabromo derivative of linoleic acid separated from cold petroleum ether solution.

The composition of this fraction, calculated by the mode of procedure of Kaufmann[7] from the iodine and thiocyanogen numbers of the oil, is shown in Table II.

TABLE II

PERCENTAGE COMPOSITION OF THE UNSATURATED ACID FRACTION

Acid	In oil		Glycerides in oil	
	Expressed	Residual	Expressed	Residual
Oleic	88.10	86.87	91.98	90.69
Linoleic	2.87	4.58	3.00	4.78

(c) **Saturated Acids.**—The methyl esters of the saturated acids of both oils were separated into four fractions of boiling range 158 to 190° and 155 to 180° (4.5 mm.), respectively. The mean molecular weights of the respective fractions as calculated from saponification and iodine numbers—the latter serving as a basis for correcting each for the presence of unsaturated acids—indicated the presence of acids in the C_{14} to C_{18} group.

The percentage composition of the saturated acid fraction of both the expressed and the residual oil is given in Table III.

TABLE III

PERCENTAGE COMPOSITION OF THE SATURATED ACID FRACTION

	Myristic		Palmitic		Stearic	
Acid	Expressed oil	Residual oil	Expressed oil	Residual oil	Expressed oil	Residual oil
In oil	0.22	0.46	3.06	3.61	1.59	1.13
Glycerides in oil	.23	.49	3.21	3.79	1.66	1.18

Summary

The important physical and chemical constants and the approximate percentage composition of the expressed oil, and that recoverable from the residual pulp, of the cultivated hazelnut, or filbert, have been determined. Except for flavor and color, the differences in composition of these fractions appear to be quantitative but not qualitative. Where such differences have been noted they are small.

MADISON, WISCONSIN RECEIVED MARCH 10, 1933
PUBLISHED AUGUST 5, 1933

(7) Jamieson, "Vegetable Fats and Oils," Chemical Catalog Co., Inc., New York, 1932, pp. 346–347.