Some Biochemical Aspects Of Soybean Oil

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Abstract

The many peculiar effects of soybean oil feeding don't bear evident relationship to the composition of its fatty acids. The known "impurities" as well as some unknown factors seem to play a leading role in defending its properties.

WHILE in 1936 nearly 200 million pounds of soybean oil were consumed in this country for edible purposes, there exists today a surprising scarcity of scientific information regarding its effect on the human and animal organism.

The main fatty acids of soybean oil (2) are: Linoleic (49.3%), linolenic (2.2%), oleic (32%), palmitic (6.5%), stearic (4.2%), and arachidic (0.7%). The comparatively high percentage of linoleic acid[1] may be of biological significance in the light of recent findings (4, 6).

In 1931 an observation was made at the University of Illinois Agricultural Experiment Station (3) that tankage-fed pigs did scarcely any rooting, while those fed soybeans kept their lot rooted thoroughly from the time the lots thawed out until the pigs were removed. This was done in spite of a mineral mixture being available at all times. The interpretation given to this phenomenon by the investigators reads that it was "an interesting study of the manner in which rations satisfied or failed to satisfy the pigs."

The data from Yale University, published in 1930, permit to attribute the rooting to the peculiar effect of soybean oil. The Yale investigators discovered a striking amount of activity exhibited by rats on a diet containing 37 per cent of soya oil. At periods of great activity several of these rats must have run constantly at a rate of 20 revolutions per minute for ten-hour periods (19).

It is, therefore, evident that soybean oil should be given wide use where enhancing of activity is desired, and that it should be completely eliminated from feeds used for fattening purposes. For this latter purpose solvent extraction soybean meal (containing only about 1 per cent oil) has therefore an advantage over expeller or hydraulic press meal (containing 4.5 per cent oil).

During the Russo-Japanese war two physicians, Korentchevsky and Zimmerman, found that crude soybean oil is digested by man to the extent of 95-100 per cent for daily doses of 100 grams[2] in addition to 46 gm. of fat present in the basic diet (11). A wide range of acidity was found by these authors in the samples of soya oil used for food in Harbin, Manchuria.

The influence of various storage conditions upon crude pressed soybean oil (mainly upon its constants) has been studied about fifteen years ago by Sychoff (11). It was found that the fat—splitting fungi[3] require a moisture content of the oil above 2 per cent as well as the access of air[4]. Recent studies (21) showed that soybean oil is rapidly ketonized by light wave lengths less than 410 mm., and that visible light of 450-650 mm., causes neither ketone nor aldehyde formation in soybean oil. A faint yellow filter protects the oil from damage by visible light.

The lipases,[5] lipoxidases (1) and peroxidases[6] of the soybeans act upon crude soybean oil in a detrimental way, the latter two enzymes acting as prooxidants.[7]

Soybean oil contains also antioxygenic substances, such as carotene, phosphatides,[8] and sterols,[9] but they are removed in the standard process of refining the oil.[10] It has been suggested (14) that it is possible to obtain an edible soya oil containing carotene, phosphatides, and sterols by using refined edible soya flour as the starting material from which the oil is secured either by pressing or solvent extraction. Such a procedure yields an edible soya oil containing also vitamins A[11] and E (8, 18, 23), in addition to an antihaemorrhagic factor,[12] the presence of which was discovered by the writer in soybeans in 1930 (12) and named by Dam (5) five years later "Vitamin K."

In 1936 a protective factor against nutritional encephalomalacia of chicks was discovered in the non-saponifiable fraction of certain edible oils, the list of which is headed by soybean oil (7).

Due to the peculiar activity-promoting properties of soybean oil, as well as the presence in crude soya oil of a number of substances other than glycerides of fatty acids, the effect of crude soybean oil on the animal organism is therefore very complex.

[1]Cottonseed oil and corn oil contain about 40% of linoleic acid.

[2]It has not yet been established whether large doses of soybean oil cause in man an increase in the blood uric acid as fats in general do. In 1926 a theory was advanced by the writer (9) that the fat absorbed by the organism is carried, at least in part, to the vicinity of nucleins in the cells, from where the phosphoric acid is taken (to convert the fat into lecithin), thus setting the purine bodies free (or in combination with substances like d—ribose). In hens, a high fat ration does not produce any noticeable rise in the blood uric acid (13).

[3]Of the species Penicilium, Fusarium, and Monilia.

[4]Old oily sediments from the sedimentation tanks produce the highest fat—splitting effect upon the oil.

[5]The writer showed in 1926 that feeding raw soybeans to animals is capable of producing fat necrosis due to lipase activity (10). More recent experimental data by other authors give support to such an assumption (17).

[6]The peroxidase value of soybeans varies with the varieties from 7.5 to 88.02 units (22).

[7]During oxidation of soybean oil peroxide groups form at the double bonds. While oxidized soybean oil is an excellent emulsifying agent for the dispersion of water in oils and fats (margarine) (14), it possesses undoubtedly also toxic properties.

[8]Crude soybean oil contains from 1 to 3 per cent phosphatides, of which nearly two-thirds consist of cephalin and nearly one-third of lecithin (15).

[9]Solvent extracted soybean oil (by benzine) contains free sitosterol esters, as well as sitosteryl—d—glucoside (16).

[10]The "beany" flavoring substance in soybean oil is attributed in part to methyl—n—nonyl ketone (20).

[11]During oxidation of soybean oil Vitamin A is destroyed.

[12]Vitamin K is confined to the oil fraction of certain oils and fats (5).

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ABSTRACTS

Oils and Fats

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Symposium on the whaling industry. Various authors. *Fette u. Seifen* **45,** 1-112 (1938).—The publications contain information on history of whaling, importance of industry, technic, hunting and processing equipment, utilization of whale meat, hydrogenation of whale oil, utilization of the oil in margarine, in soap, for illuminating, in paint, in leather manuf. and for linoleum manuf., and statistics.

Progress in the knowledge of fats. XV. Glycerides of babassu fat. A. Bomer and H. Huttig. *Z. Untersuch. Lebensm.* **75,** 1-33 (1938).—Kernels contained 68.8% fat of m.p. 25°, sapon. No. 251.1, I No. 15.6, acid No. 2.0, R. M. No. 5.9, Pol. No. 11.6, butyric acid No. 0.4, *n* (30°) 40.5 at (40°) 35.0, unsapon. 0.3%. The fat was fractionally distilled. Data on fractions and refractioned fractions were presented. Of the pure glycerides separated myristodilaurin m.p. 34.7 was found in large amts.; some laurodimyristin was found and also small amounts of palmitodimyristin (m. p. 45.7). The still residue contained stearo-dipalmitin (m.p. 55.9); its amt. in the total fat was small.

Oiticica and tung oils. S. O. Sorenson and C. J. Schumann, J. H. Schumann and J. Mattiello. *Ind. Eng. Chem.* **30,** 211-15 (1938).—Commercial batches of oiticica and tung oils were heat-bodied to a wide range of viscosities at varying temperatures. Batches of 250 gals. of oiticica oil were heat-bodied at 450° and 490° F. in air; 1 batch of 215 gals. was heat-bodied electrically at 450° F. in a closed system, under a blanket of CO_2. A batch of 250 gals. of tung oil was heat-bodied at 450° F. in air. The following properties were detd. on samples taken at regular intervals during the runs; viscosity, mol. wt., acid No., sp. gr., refractive index, and sapon. No. The variation of each of these properties with respect to heating time and viscosity is presented in graphical form. The gelation time for oiticica and tung oils at temps. from 400-600° F. was observed. The temp. coefficient for refractive index was detd.

Composition of olein. J. Davidsohn and A. Davidsohn. *Ind. Chemist,* **13,** 402-4 (1937).—The following consts. are suggested for "textile olein special": sp. gr. not below 0.892, acid value 183-208, sapon. No. not over 212, m. p. of fat acids not over 18°, unsaponifiable not over 8%, Mackay test not higher than 103° in 1.5 hrs., and 110° in 2 hrs., flash point not below 168°, setting point not above 6°, cloud point not above 12°, H_2O not over 0.5% and ash not over 0.2%. Products complying with the above but contg. β-naphthol should be designated "textile olein special plus β-naphthol." (*Chem. Abs.*)

The problem of rancidity in fixed oils used for the finishing of textile fabrics. K. L. Dorman. *Amer. Dyestuff Reporter* **27,** 89-92 (1938.)—A general discussion of the problem.

Detection and rapid determination of lead in edible oil. Vizern and Guillot. *Ann. chim. anal. chim. appl.* **19,** 252-60 (1937).—Olive oil sometimes contains a little Pb which makes it fail to pass legal restrictions for such purposes as canning sardines. The procedure described here serves to show within an hr. whether a sample contains Pb and whether it contains more than the legal limit. Take 50 g. of oil in a Pyrex flask of 500 ml. and dissolve the sample in 200 ml. of petr. ether contg. 1 ml. of AcOH. Heat to boiling under a reflux, water-cooled condenser. Cool, add 5 ml. of 50% alc. and shake vigorously for 1 min. Filter through a moist filter. Repeat the treatment with alc. 3 times. After the fourth treatment, unite all the aq. alc. exts. which will contain practically all of the Pb. Det. the Pb colorimetrically by comparison with a soln. contg. like quantities of alc., water and AcOH and a known quantity of Pb $(OAc)_2$, taking advantage of the brown coloration of PbS produced by adding 1 ml. of water satd. with H_2S. (*Chem. Abs.*)

The contamination of whale oil with fuel oil. E. R. Bolton, and K. A. Williams. *Analyst* **63,** 84-93 (1938).—In the whale oil floating factories there is sometimes contamination of the oil with fuel oil. This is due to the use of tanks for carrying fuel oil on the outward journey and for transporting whale oil on the return journey. The presence of the fuel oil reduces the quality from the standpoint of color and ease of hydrogenation. Methods for detecting fuel oils in fatty oils are reviewed. The author describes a method. Twenty grams of whale oil sample dissolved in 80 c.c. of petrol ether are filtered through a column of 6 to 8 in. of Al_2O_3 contained in a 2/3 to 1 in. tube, and the oxide is washed with petroleum ether. The first inch of the Al_2O_3 is shaken with 50 c.c. of ether, filtered and the filtrate evapd. The residue is dissolved and the preceding is repeated with a fresh Al_2O_3 filled tube. The final residue is dark brown if more than .005% fuel oil is present.

Separation of the highly-unsaturated acids of fish oils by molecular distillation. E. H. Farmer and F. A. Van den Heuvel. *J. Soc. Chem. Ind.* **57,** 24-31 (1938).—It has been shown that molecular distillation affords a satisfactory and expeditious method for separating the groups of acids of different chain lengths contained in mixed acids of fish oils without promoting isomerisation or polymerisation and that the refractive index/hydrogen value relationship furnishes an ap-