A Note on the Composition of Wheat-Germ Oil

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Abstract

Preliminary to an exploration of the possibilities for the increased industrial utilization of wheat oils, the proximate analysis of a commercially available wheat-germ oil has been repeated in the light of present conceptions of the significance of the analytical constants of the unsaturated fatty acids.

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IN 1936, Sullivan and Bailey (15) reviewed the previous analyses and made a comprehensive study of the wheat-germ lipids. However, they based their calculations of the concentrations of the oleic, linoleic, and linolenic acids upon the thiocyanogen values as given by Kaufmann and Keller (8) and upon the iodine values as found by the procedure of Rosenmund and Kuhnhenn (13).

It is now commonly agreed that the actual thiocyanogen values of the unsaturated acids, especially of linolenic acid, deviate considerably from the theoretical values proposed by Kaufmann and Keller. Likewise, the pyridine-sulfate-dibromide reagent of Rosenmund and Kuhnhenn has been shown by Earle and Milner (2) to give lower iodine values than the officially accepted Wijs iodine-chloride solution with oils having iodine values over 100, i.e., with those oils containing relatively large amounts of linoleic and linolenic acids. The Wijs reagent, on the other hand, has been found (5, 6, 10) to give essentially the theoretical iodine values for these acids. A simple recalculation of the composition of wheat-germ oil, by using the values obtained by Sullivan and Bailey in the newer empirical thiocyanogen-iodine number equations, is therefore not possible, and it was considered desirable to repeat the analysis of this oil.

The results obtained in the present work are compared with the corresponding data of Sullivan and Bailey in the accompanying table. It is understood, of course, that the data are not strictly comparable because of differences in the samples. As may be expected in an oil containing a relatively low ratio of linolenic acid to the preponderating linoleic and oleic acids, the correction due to the empirical thiocyanogen-iodine number equations is slight, although significant, and it results in higher values for linolenic acid (4).

Physical and Chemical Characteristics of Wheat-Germ Oil

	Present Investigation (cold-pressed)	Sullivan and Bailey (15) (alcohol-ether-extracted)
Moisture, per cent	0.08	....
Specific gravity	0.9268 (25°/25°C.)	0.9326 (26°/26°C.)
Refractive index	1.4737 (30°C.)	1.4800 (20°C.)
Acid value	8.25	6.95
Saponification value	184.0	184.0
Iodine number	128.6 (Wijs)	125.0 (Rosenmund)
Thiocyanogen number	82.0	84.7
Unsaponifiable, per cent	4.04	4.00
Total fatty acids—unsaponifiable free:		
Iodine number	135.6 (Wijs)	129.9 (Rosenmund)
Thiocyanogen number	84.3	79.3
Saturated acids (Bertram), per cent	14.9	17.87
Saturated acids (Earle and Milner), per cent	16.1	....
Saturated acids (Twitchell)	....	16.00
Saturated acids, average per cent	15.5	16.9
Hexabromide number	6.6	5.0
Oleic acid, per cent	25.5	28.14
Linoleic acid, per cent	52.6	52.31
alpha	....	22.32
beta	....	29.99
Linolenic acid, per cent	6.3	3.55
alpha	....	1.83
beta	....	1.72

The concentration of linolenic acid in the present sample was also calculated from the hexabromide number of the acids by the equation of Shinowara and Brown (14):

$$\frac{6.6 \text{ x } 100}{92} = 7.2\% \text{ linolenic acid}$$

in which 6.6 is the hexabromide number of the fatty acid mixture and 92 is the average hexabromide number of natural linolenic acid. The value obtained by this method may be considered in fair agreement with the value of 6.3% linolenic acid obtained by the thiocyanogen technique. It is noteworthy that the application of Shinowara and Brown's equation to the hexabromide number reported by Sullivan and Bailey for their sample raises their value for linolenic acid to 5.4%, rather than the 3.55% they obtained by calculation from their thiocyanogen-iodine numbers. Furthermore, in view of the recent work on the bromination of linolenic and linoleic acids (6, 7, 9, 10, 12) significance can no longer be attached to the differentiation of the alpha and beta forms of these acids in wheat-germ oil.

Experimental

THE material was a commercial sample of wheat-germ oil (ARPRO—General Mills, Inc.). The officially recommended methods of the American Oil Chemists' Society were used except where noted.

The solid acids were determined by the oxidation procedure of Bertram (1) and by the low-temperature crystallization technique of Earle and Milner (3). The average of the duplicate values obtained by both methods was used in the calculations.

The average thiocyanogen number of 82.0 found for the whole oil was the result of six determinations, which were 83.4, 81.9, 81.1, 80.5, 81.1, and 83.9. For the acids, free of unsaponifiables, the value of 84.3 was the average of seven determinations, which were 84.5, 84.3, 84.3, 84.8, 85.3, 83.1, and 84.2. These were obtained with an approximately 150% excess of 0.2 N freshly prepared thiocyanogen solution and a reaction period of 24 hours at 19°C. The empirical equations prepared by Riemenschneider, Swift, and Sando (11) were used in calculating the composition of the fatty acid mixture. Recalculation using the equations recommended by the Fat Analysis Committee of the American Oil Chemists' Society (16) resulted in less than 0.1 unit error in any value reported.

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Abstracts

Oils and Fats

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Report of the committee on analysis of commercial fats and oils. V. C. Mehlenbacher *et al. Ind. Eng. Chem., Anal. Ed. 17*, 336-40 (1945). Activities on (SCN) value, fat stability test, hexabromide test, congeal point, unsaponifiable matter and color are recorded.

A new technique for examining cod oils for currying and chamoising. D. Burton and G. F. Robertshaw. *J. Intern. Soc. Leather Trades' Chem. 29*, 28-45 (1945). The difficulty of assessing the quality and properties of cod oil is illustrated by the variation in the analytical figures given by different authorities for Newfoundland cod oil. The unsaponifiable matter is an important constituent of cod oil and is useful in showing the presence of adulterants. The polybromide index may be a useful guide as to the suitability of a cod oil for currying when sufficient results are available to serve as standards. Gummy spue has been obtained in practice with 2 oils giving values of 45 and 46. A new technic has been evolved for isolating and determining the properties of the free fatty acids, and the "liquid" and "solid" fatty acids derived from the glycerides. In examining a series of commercial cod oils and a herring oil, it has been shown that (1) the free fatty acids isolated from 3 of the cod oils were solid, (2) 3 of the oils rapidly thickened and formed a skin after removal of their free fatty acids and (3) the "liquid" fatty acids from 4 of the cod oils changed into pale yellow sticky compounds, insoluble in petroleum ether, on standing. It has been shown that cod oils for currying should contain about 6% of free fatty acids and that oils containing 14% or more should not be used since the high melting-point fatty acids tend to spue to the surface and carry the oxidizable oil with them and so lead to gummy spue. This can be prevented by using mineral oil along with the cod oil in the currying.

Collection of sludge fat. G. Chr. Kornmesser. *Gesundh.-Ing. 65*, 24 (1942); *Wasser u. Abwasser 40*, 56 (1942). The yield of fat is increased by leaving some sludge on the H_2O surface of the fat separator. The size of fat separator is determined by the number of animals handled in slaughter houses, and by the number of meals served in eating houses. (*Chem. Abs.*)

Potentiometric precipitation titration of high-molecular fatty acids with $AgNO_3$. Per Ekwall and Gösta Juup. *The Svedberg 1944*, 104-12. At 67-70° the Na salts of lauric, myristic, palmitic and stearic acids can be titrated potentiometrically with 0.02-1.1 N $AgNO_3$. The titration curves are typical with breaks of 100-250 mv. at the end points. Titration of soap solutions gave results which were 1-5% too low, possibly because undecomposed soap was included in the Ag precipitates. The solubility of the different Ag salts can be calculated approximately from the titration curves and if the molecular weight of the acid differs by more than 2 CH_2 groups from that of another acid, the 2 acids can be titrated independently in a mixture. Two saturated acids with an even number of C atoms of fairly close molecular weight are hard to titrate in the presence of one another but these preliminary experiments indicate that the difficulty can probably be overcome. (*Chem. Abs.*)

Determination of gamma-tocopherol in vegetable oils. G. S. Fisher. *Ind. Eng. Chem., Anal. Ed. 17*, 224-7 (1945). The details of a method for determining γ-tocopherol in the presence of α-tocopherol by oxidation with nitric acid in the presence of acetic acid, followed by photometric estimation of the red color produced, are presented with results of its application to several vegetable oils. Use of the method presupposes absence of β-tocopherol.

South African fish products. Part XIII. The jacopever, Sebastichthys capensis (Gmelin) and the sancord, Helicolenus maculatus (C. and V.). W. S. Rapson, H. M. Schwartz and N. J. Van Rensburg. *J. Soc. Chem. Ind. 64*, 47-50 (1945). Fat storage in the jacopever has been studied at monthly intervals over a period of one year. Head, body, liver, intestine and pyloric caeca are all used as fat depots, though the liver and other visceral organs are of minor importance in this respect, each containing approximately 10% of the total lipoid matter. The head and body are the main fat depots, containing the residual lipoid matter in approximately equal proportions. The head is the organ least susceptible to changes in oil content. The seasonal variation in fat content was of the same type as that already recorded for the other fishes from the west coast so far examined; that is, the fat content was at a maximum in the early winter and at a minimum in the spring. The vitamin-A and -D contents for the liver and visceral oils are recorded. The liver oils were more saturated than those from the other organs, but the relative degree of saturation was dependent on the condition of the fish. Some discussion of this latter effect is given. Oil distribution in the closely related sancord has also been studied and found