The Composition of Soy-Bean Oil¹

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VERY little seems to have been published regarding the composition of soy-bean oil, although many data concerning its "constants" have appeared in the last few years. Matthes and Dahle's³ statement that the fatty acids consist of 15 per cent palmitic, 56 per cent oleic, 19 per cent linolic, and 5 per cent linolenic acids, has been quoted recently, but as the iodine number of such a mixture is 99, while soy-bean oil has an iodine number around 130, it is evident that this is not the correct composition.

The principal reason for the discrepancy lies in the fact pointed out by Jamieson and Baughman,⁴ that a large proportion of the linolic tetrabromides of some oils remains in solution in the mixture of oleic dibromide and petroleum ether. When this fact is recognized, the correlation of the analysis of the unsaturated acids with the known constants becomes simplified. Some of the chief constants which have been published are the following:

	1	2	3	4
Specific gravity 15.6°/15.6°	1.4741	1.4734	0.9249	0.9245
Index of refraction, 25° C.	1.4741	1.4734	1.4732	1.4734
Iodine number (Hanus)	134.0	133.1	129.4	132.6
Free fatty acids, per cent.	0.8	....	....	....
Insoluble acids + unsaponifiable, per cent.	95.3	....	....	....
Soluble acids, per cent.	0.3	....	....	....
Unsaponifiable matter, per cent.	1.0	....	....	....
Solid acids, per cent.	9.7	7.74	11.6	9.60
Iodine number	5.7	5.0	....	7.4
Melting point	53.5	52.5	....	53.4
Molecular weight	274	271	....	....
Liquid acids, per cent.	85.5	....	83.5	....
Iodine number	....	151.7	....	154.4
Hexabromides (m. p. 181°), per cent.	6.55	7.23	....	....
Linolenic acid, per cent.	2.40	2.60	....	....

acids when corrected for this becomes 9.3. This result is very close to that of Fellers.⁵ Owing to the small quantities of solid acids recovered, tests of their character were inconclusive. According to Matthes and Dahle,³ palmitic acid is the only saturated acid present.

The percentage of linolenic acid in soy-bean oil appears to

INDEX OF REFRACTION							
	Fellers ¹	Matthes and Dahle ²	Oettinger and Buchta ³	Low ⁴	Bailey and Baldsiefen ⁵	Lewkowitsch ²	Steele and Washburn ⁷
Maximum	1.4750(25°)	1.4680(40°)	1.4755(20°)	..	..	..	..
Minimum	1.4720	....	1.4745	..	..	..	..
IODINE NUMBER							
Maximum	132.3	....	....	138.4 (Wijs)	135.5	..	..
Minimum	123.2	....	....	137.4	133.2	..	..
SAPONIFICATION NUMBER							
Maximum	195.8	....	....	..	..	192.5	..
Minimum	190.2	....	....	..	..	190.6	..
INSOLUBLE ACIDS AND UNSAPONIFIABLE MATTER							
Maximum	94.3	95.5	96.0	96.1	..	..	..
Minimum	93.0	....	95.8	..	..	..	..
UNSAPONIFIABLE MATTER (PER CENT)							
Maximum	....	....	0.59	1.16	..	..	..
Minimum	....	....	0.39	..	..	..	..
REICHERT-MEISSL NUMBER							
Maximum	5.2	....	0.56	..	..	..	..
Minimum	4.3	....	0.45	..	..	..	..
SOLID ACIDS (PER CENT)							
Maximum	9.2	....	....	..	..	..	17.01
Minimum	8.6	....	....	..	..	..	..
LIQUID ACIDS (PER CENT)							
Maximum	85.7	....	....	..	..	..	..
Minimum	84.9	....	....	..	..	..	..
HEXABROMIDES (PER CENT)							
Maximum	....	....	....	..	7.5	7.78	2.2
Minimum	....	....	....	..	4.2	5.07	..
Average	....	....	....	..	6.0	..	..

¹ THIS JOURNAL, 13 (1921), 689.

² Lewkowitsch, "Oils, Fats, and Waxes," 5th edition, II, 116; I, 575.

³ Z. angew. Chem., 1911, 24, 828.

⁴ THIS JOURNAL, 12 (1920), 572.

⁵ Ibid., 12 (1920), 1193.

⁶ Ibid., 13 (1921), 807.

⁷ Ibid., 12 (1920), 59.

EXPERIMENTAL

Analyses bearing on the subject have been made on four samples of soy-bean oil, representing four different sources as well as more than ten years' time. Standard methods were employed in every case, more than ordinary care being observed.

These analyses average 9.7 per cent of solid acids, with an average iodine number of 6. Taking the iodine value of the unsaturated acids as 153, the solid acids contain about 4 per cent of unsaturated acids, so that the percentage of saturated

have been well worked out. Excluding Steele and Washburn's result,⁶ which is much lower than the others, the limits are from 4.2 to 7.8 per cent of hexabromide, corresponding to 1.54 to 2.86 per cent of linolenic acid. Bailey and Baldsiefen found the average of hexabromides to be 6.0, equivalent to 2.2 per cent of linolenic acid. The average of 2.5 per cent found experimentally agrees with these figures.

The palmitic and linolenic acids account for less than 12 per cent of the oil, which must contain a large proportion of linolic acid. To determine this, Oil 1 was tested in the manner described by Jamieson and Baughman.⁴ The filtrate from the hexabromide determination was freed from ether

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³ Lewkowitsch, "Oils, Fats, and Waxes," 5th edition, II, 116; I, 575.

⁴ J. Am. Chem. Soc., 42 (1920), 1199.

⁵ THIS JOURNAL, 13 (1921), 689.

⁶ Ibid., 12 (1920), 59.