CCXLI. THE COMPONENT FATTY ACIDS OF THE PHOSPHATIDES OF SOYA BEAN AND RAPE SEEDS

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THE fatty acids present in combination in phosphatides from the vegetable kingdom have received less notice hitherto than those from animal sources. Until Levene & Rolf [1925; 1926] published the results of their study of soya bean phosphatides, plant phosphatides were usually supposed to be varieties of lecithin and the only acid components which had been reported were palmitic, stearic and oleic—in the “lecithins” respectively of leguminous seeds [Schulze & Likiernik, 1891; Njegovan, 1911], sugar-cane [Shorey, 1898], and beet-root [Grafe & Horvat, 1925]. Levene & Rolf, in the case of soya bean phosphatides, showed that more than one type was present, including products less soluble in alcohol than lecithin, and that the phosphatides sparingly soluble in alcohol and also the alcohol-soluble forms gave optically active barium glycerophosphate, indicating that the phosphoric acid was combined with an α -glyceryl hydroxyl group. They identified palmitic, stearic and (in the form of bromo-additive products) oleic, linoleic and linolenic acids in the mixed fatty acids; they concluded that in the alcohol-soluble phosphatides (choline compounds) the proportion of saturated acids was lower than in animal lecithin, whereas the alcohol-insoluble compounds (β -aminoethanol derivatives) showed no marked difference in this respect from animal kephalin.

Webster [1929] recorded the i.v. (Hanus) of the mixed fatty acids present in the acetone-insoluble phosphatides from wheat, maize, oats and soya beans respectively as 81.5, 65.3, 88.8 and 92.5.

The only other detailed work on seed phosphatide fatty acids (again those from the soya bean) appears to be that of Suzuki and his co-workers [1930; 1931]. The presence of alcohol-insoluble “kephalin” and alcohol-soluble “lecithin” derived respectively from choline and β -aminoethanol was confirmed by these investigators, who also brominated the phosphatide fractions and isolated various crystalline derivatives containing mixtures of fatty acids, from which the presence of “mixed” compounds such as palmito-oleo-, or oleolinoleo-, as well as dioleo- and dilinoleo-phosphatides was established. Suzuki & Yokoyama [1930] separated, by means of cadmium chloride double salts, α - and β -“lecithins” from soya beans, and studied the mixed fatty acids from each group by bromination. They observed the following proportions of palmitic and polybromostearic acids in each case:

Acids	From “ α -lecithin”	From “ β -lecithin”
Palmitic	24.3	20.1
Dibromostearic	32.4	53.8
Tetrabromostearic	44.2	24.8
Hexabromostearic	1.1	1.4

The corresponding proportions of the fatty acids originally present would therefore be:

Acids	From "α-lecithin"	From "β-lecithin"
Palmitic	36.8	30.2
Oleic	31.3	51.6
Linoleic	31.3	17.4
Linolenic	0.6	0.8

These figures differ widely from those which we have found in the course of the present work, the amounts of palmitic and oleic acids being much higher, at the expense of linoleic acid. A possible explanation is that the yield of crystalline tetrabromostearic acid, M.P. 114°, never represents more than 50% of the linoleic acid actually present [cf. Green & Hilditch, 1935].

Recently Jamieson *et al.* [1937] have further discussed the separation of the mixture of phosphatidic compounds present in soya beans, and have put forward evidence that in the seed the phosphatides may be united with carbohydrates in compounds resembling glucosides. On the other hand, Rewald [1929; 1933; 1936; 1937] holds that, although plant phosphatides are closely associated with carbohydrates in the seed, the union is not of a chemical nature, since by appropriate physical methods (e.g. extraction from an aqueous emulsion with a suitable solvent) the phosphatides can be separated in a relatively pure condition and free from either carbohydrate or fat.

We are indebted to Dr Rewald for kindly supplying us with phosphatide fractions (soluble and insoluble in alcohol) separated from soya beans and from rape seed, and freed as far as possible from non-phosphatidic material by the procedures which he has found most efficient for their purification. We have confined our attention to the composition of the mixed fatty acids present in these products. When the quantity available permitted, the component acids were determined by the customary ester-fractionation procedure, accompanied by detailed qualitative examination of certain ester fractions in order to identify the unsaturated acids present.

Phosphatides from soya bean

Samples of the alcohol-insoluble ("kephalin") and alcohol-soluble ("lecithin") phosphatides were both available. The former, a soft granular brownish substance, was by far the larger portion and we were able to make an exhaustive examination of the fatty acids. The alcohol-soluble phosphatides were much less in amount and formed a thick, dark-coloured paste which, unfortunately, oxidized with great rapidity on exposure to air. The general characteristics of the soya bean phosphatides are given in Table I.

Table I. *Soya bean phosphatides*

	Alcohol-insoluble	Alcohol-soluble
P	3.7%	3.82%
N	1.4%	1.56%
I.V.	94.2	83.5
Sap. equiv.	242.7	254.4
Mixed fatty acids:		
Yield from phosphatide	69%	70%
Equiv.	283.2	277.5
I.V.	131.9	128.6

Alcohol-insoluble phosphatide from soya bean

The mixed fatty acids were prepared from 110 g. of the material by hydrolysis. Direct hydrolysis with alcoholic KOH was somewhat difficult, and (following Levene & Rolf [1925; 1926] and Suzuki *et al.* [1930; 1931]) we found it better first to reflux the phosphatide in alcohol containing 0.5% H_2SO_4 for 3 hr. Sufficient KOH was then added to neutralize the H_2SO_4 and give a 5% solution of the alkali, after which the mixture was again refluxed for 3 hr. The recovered soaps were decomposed and extracted with ether in the usual manner. We invariably encountered, at this stage, small quantities of a substance, insoluble in both ether and water, the nature of which we have not established. It amounted to 3–4% of the weight of phosphatide taken and formed a cream-coloured amorphous powder, M.P. about 260° with decomposition. It did not contain P or N, it was insoluble in hot and cold water, alcohol or benzene and was apparently unaffected by boiling with aqueous alkali.

The mixed fatty acids were submitted to a lead salt-alcohol separation and the "solid" (15.4%) and "liquid" (84.6%) acids separately converted into methyl esters and fractionally distilled with the results given in Table II.

Table II

Methyl esters of "solid" acids

No.	g.	Sap. equiv.	I.V.
S 1	3.12	274.2	3.8
S 2	2.80	275.8	6.9
S 3	2.54	278.9	9.2
S 4	3.66	322.1*	24.6
	12.12		

Methyl esters of "liquid" acids

Primary fractionation				Refractionation of fraction L 1			
No.	g.	Sap. equiv.	I.V.	No.	g.	Sap. equiv.	I.V.
L 1	21.09	285.1	131.3	L 11	4.04	271.6	85.6
L 2	5.30	290.2	133.8	L 12	4.07	282.5	107.7
L 3	5.73	291.4	154.5	L 13	4.16	286.7	133.5
L 4	6.57	292.9	161.1	L 14	4.51	291.1	158.7
L 5	5.21	292.6	161.2	L 15	3.79	293.5	166.7
L 6	5.07	294.2	166.3		20.57		
L 7	5.78	295.0	159.5				
L 8	5.50	308.1*	137.2				
L 9	5.17	430.2*	104.5				
	65.42						

* Sap. equiv. of esters, freed from unsaponifiable matter: S 4, 308.5; L 8, 293.6; L 9, 323.0.

Identification of unsaturated acids present in fractions L 11, L 5 and L 6. The acids from fractions L 11 and L 5 were oxidized in dilute ice-cold alkaline solution with KMnO_4 according to the procedure of Lapworth & Mottram [1925]. The oxidation products were separated by systematic crystallization from light petroleum, water and, finally, ethyl acetate or alcohol.

The acids (3.55 g.) from fraction L 11 gave, in addition to the two tetrahydroxystearic acids (M.P. and mixed M.P., 156° and 172° respectively), a small amount (0.22 g.) of not wholly pure palmitic acid (M.P. 58°) and a small quantity of an acid (M.P. 124° ; found C 66.7, H 10.8%) which corresponded with 9:10-dihydroxypalmitic acid (M.P. 124° [Armstrong & Hilditch, 1925]; calc. C 66.7,

H 11.1 %). The acids (4.5 g.) from fraction L 5 yielded relatively large quantities of the tetrahydroxystearic acids, M.P. 172° and 155°, a smaller quantity of 9:10-dihydroxystearic acid (M.P. 131.5°) and, in addition to traces of saturated acid (M.P. 54°), a very small quantity of an acid, comparatively freely soluble in hot water, which melted at about 200°. The amount of the latter precluded further purification, but it appeared to be impure hexahydroxystearic acid.

The presence of large proportions of the linoleic acid of seed-fats, indicated by these oxidation experiments, was confirmed by the bromo-additive products obtained from the acids of fraction L 6. These acids (4.53 g.) yielded 1.24 g. (M.P. 114°, Br 56.7 %) of bromo-additive products insoluble in ether and 2.93 g. (M.P. 113.5°, Br 53.6 %) of the latter insoluble in light petroleum (but soluble in ether); the residual products, soluble in both light petroleum and ether, amounted to 6.64 g. (Br 49.3 %). These data show that the tetrabromostearic acid (M.P. 114°, Br 53.3 %, characteristic of seed-fat linoleic acid) was present in such abundance that some of it separated from ether. The observed bromine content of 56.7 % indicates the presence of about 0.4 g. of hexabromostearic acid in this fraction, corresponding with about 0.15 g. of linolenic acid; the total content of linolenic acid is probably, therefore, about double this amount, or not more than 7 % of the C₁₈-unsaturated acids (equivalent to 4 % of the total fatty acids, cf. Table III). The total amount of crystalline tetrabromostearic acid (3.8 g.) isolated corresponds to about 39 % of the acids of fraction L 6; if the latter (i.v. 174.6) contain 7 % of linolenic acid, the rest is made up of 79 % linoleic and 14 % oleic acid. The yield of crystalline tetrabromostearic acid is thus, as usual, somewhat less than half of the theoretical quantity. It will be noted that large quantities of a form of tetrabromostearic acid soluble in light petroleum were present in the soluble residue (Br 49.3 %).

The final results for the composition of the mixed fatty acids are in Table III. The ester fractions L 1–L 5 (Table II) have been calculated as mixtures of hexadecenoic (and palmitic) ester with C₁₈-unsaturated esters of i.v. 166.3, whilst fraction S 4 has been calculated to a mixture of stearic, arachidic, oleic and eicosenoic esters.

Table III. *Component acids of alcohol-insoluble phosphatide from soya bean*

	"Solid" acids S (15.4 %)	"Liquid" acids L (84.6 %)	Total	Component acids	
				% (wt.)	% (mol.)
Palmitic	8.13	3.34	11.47	11.7	13.1
Stearic	3.87	—	3.87	4.0	4.0
As arachidic	1.37	—	1.37	1.4	1.3
Hexadecenoic	—	8.37	8.37	8.6	9.6
Oleic	1.35	4.07	5.42	5.5	5.7
Linoleic*	—	61.83	61.83	63.3	61.5
As C ₂₀ unsaturated	0.48	4.88	5.36	5.5	4.8
Unsaponifiable	0.20	2.11	2.31	—	—

* Includes a small amount of linolenic acid (not more than 4 % of the total fatty acids). If 4 % of linolenic acid is present, the molar proportions of oleic and linoleic acids in the component acids in Table III would be altered to 10 % and 53.5 % respectively.

A separate portion (49 g.) of the mixed fatty acids obtained by hydrolysis of the alcohol-insoluble phosphatide was converted, after removal of unsaponifiable matter, into methyl esters and hydrogenated as completely as possible (i.v. 2.4) before fractionation. The ester fractionation analysis gave the molar percentages of the components of the hydrogenated acids as palmitic

20.8, stearic 75.6 and arachidic 3.6. These figures accord fairly well with the total molar percentages for acids of the same carbon content as calculated in Table III (namely, C_{16} 22.7, C_{18} 71.2 and C_{20} 6.1). The value for unsaturated C_{20} acids in Table III appears to be somewhat high, possibly owing to the difficulty of complete removal of unsaponifiable components present in fractions L 8 and L 9. The figure for palmitic acid in the hydrogenated acids justifies the assumption that hexadecenoic esters are present in fractions L 1–L 5, which is further supported by the identification of dihydroxypalmitic acid in the oxidation products of the acids from fraction L 11.

Alcohol-soluble phosphatide from soya bean

The quantity of this material available (35 g.) was much less than in the preceding case and unfortunately, as already mentioned, it had evidently become somewhat oxidized before it could be studied. 24.6 g. of fatty acids were obtained on hydrolysis and submitted to lead salt-alcohol separation. The "solid" acids (4.6 g., equiv. 258.9, i.v. 10.2, excluding 3% unsaponifiable matter also present) were calculated as a mixture of palmitic and oleic acids. The "liquid" acids (20.0 g.) were converted into methyl esters and fractionated as shown in Table IV.

Table IV. *Methyl esters of "liquid" acids*

Primary fractionation				Refractionation of fraction L 1			
No.	g.	Sap. equiv.	i.v.	No.	g.	Sap. equiv.	i.v.
L 1	9.77	284.7	146.5	L 11	1.35	259.1	126.9
L 2	2.61	291.7	146.3	L 12	3.04	285.6	140.3
L 3	3.08	293.1	111.8	L 13	2.64	290.7	153.3
L 4	4.20	305.3*	111.7	L 14	2.63	292.0	157.1
	19.66				9.66		

* Esters of L 4, freed from unsaponifiable matter, sap. equiv. 297.5.

Oxidation of the acids from fraction L 13 by dilute alkaline permanganate again yielded the tetrahydroxystearic acids, m.p. 156° and 173°, corresponding with seed-fat linoleic acid, and also very small quantities of an acid, soluble in hot water, which melted and decomposed at 200°. Similar treatment of the acids of fraction L 11 gave, in addition to the tetrahydroxystearic acid, m.p. 171°, small amounts (insufficient for adequate characterization) of saturated acids and of an acid, m.p. 127°.

Addition of bromine to the acids (1.87 g.) of fraction L 14 produced 0.15 g. of products insoluble in ether (m.p. 174°, Br 62.9%), 1.60 g. of products soluble in ether but insoluble in light petroleum (m.p. 112°, Br 53.9%) and 2.40 g. of oily products soluble in both solvents (Br 48.1%). The ether-insoluble fraction corresponds closely with crystalline hexabromostearic acid (m.p. 176°, Br 63.3%) and is equivalent to 0.05 g., or 2.5%, of linolenic acid in the acids of L 14. The fraction insoluble in light petroleum is equivalent to 0.75 g., or 40% of linoleic acid. Assuming that, as usual, only 50% of the linolenic acid present has been returned in the form of crystalline hexabromostearic acid, it is probable that about 5% of the C_{18} unsaturated acids is linolenic acid. From the i.v. of the acids of fraction L 14 (165.0), therefore, the composition of the C_{18} unsaturated acids is in the region of 5% linolenic, 72% linoleic and 23% oleic. Employing these figures, we arrive at the approximate composition for the mixed fatty acids of the alcohol-soluble soya bean phosphatide given in Table V.

Table V. *Component acids of alcohol-soluble phosphatide from soya bean*

	"Solid" acids S (18.7%)	"Liquid" acids L (81.3%)	Total	Component acids	
				% (wt.)	% (mol.)
Palmitic	16.08	1.07	17.15	17.3	18.6
Hexadecenoic	—	5.47	5.47	5.5	6.0
Oleic	2.07	16.74	18.81	19.0	18.5
Linoleic	—	52.40	52.40	53.0	52.0
Linolenic	—	3.65	3.65	3.7	3.6
As C ₂₀ unsaturated	—	1.49	1.49	1.5	1.3
Unsaponifiable	0.55	0.48	1.03	—	—

This analysis must be regarded as less reliable than that of the acids from the alcohol-insoluble phosphatides, owing to the small amount of material available. Further, the i.v. of the unsaturated acids are probably several units low (in consequence of atmospheric oxidation of the phosphatides) and the figures for linoleic and oleic acids are likely to be correspondingly lower and higher than the true values.

Phosphatides from rape seed

The quantities of material at our disposal were less here in each case than with the soya bean phosphatides, namely, about 70 g. of alcohol-insoluble and about 5 g. of alcohol-soluble rape seed phosphatides. The two fractions resembled the respective soya bean products in appearance, and the alcohol-soluble substance appeared to have undergone oxidation to some extent and to have darkened in colour. The general characteristics of the rape seed phosphatides are summarized in Table VI.

Table VI. *Rape seed phosphatides*

	Alcohol-insoluble	Alcohol-soluble
P	3.63%	3.58%
N	1.45%	1.12%
i.v.	84.8	71.7
Sap. equiv.	275.9	262.2
Mixed fatty acids:		
Yield from phosphatide	68%	61%
Equiv.	297.2	—
i.v.	114.2	117.9

Alcohol-insoluble phosphatide of rape seed

The mixed fatty acids (45 g.) from 66 g. of the alcohol-insoluble phosphatide were resolved by lead salt-alcohol separation into 20.2% "solid" and 79.8% "liquid" acids, each group being methylated and fractionated with the results shown in Table VII.

The high i.v. of the "solid" esters, and the equivalents of fractions S 3 and L 14, L 3-L 6, suggested that, as in rape seed glycerides, erucic acid was present in some quantity. This was confirmed by the qualitative identification tests made on the acids from several of the ester fractions.

The acids (2.62 g., freed from unsaponifiable matter) from fraction S 3 were oxidized in cold dilute alkaline solution with permanganate, and thereby gave 0.30 g. of saturated fatty acids (m.p. 78°) and also 1.51 g. of an acid m.p. 128° (mixed with 13:14-dihydroxybehenic acid, m.p. 127°).

Table VII

Methyl esters of "solid" acids

No.	g.	Sap. equiv.	I.V.
S 1	2.27	274.3	27.8
S 2	2.25	295.1	52.6
S 3	3.35	362.1*	58.1
	7.87		

Methyl esters of "liquid" acids

Primary fractionation				Refractionation of fraction L 1			
No.	g.	Sap. equiv.	I.V.	No.	g.	Sap. equiv.	I.V.
L 1	12.73	291.8	132.9	L 11	2.96	284.9	101.4
L 2	2.91	295.7	141.4	L 12	3.09	288.5	130.0
L 3	2.77	301.6	140.4	L 13	3.86	293.1	146.9
L 4	2.88	303.9	138.7	L 14	2.64	302.6	144.0
L 5	3.19	316.3	123.4		12.55		
L 6	3.73	429.9*	94.4				
	28.21						

* Sap. equiv. of esters, freed from unsaponifiable matter: S 3, 352.2; L 6, 334.8.

Similar oxidation of the acids from fraction L 3 gave mainly the tetrahydroxystearic acids of m.p. 155° and 172°, with traces of an acid, m.p. 205° (hexahydroxystearic acid) and of an impure dihydroxy-acid which melted indefinitely at 125°; while from the acids (2.6 g.) of fraction L 11 there were obtained the two tetrahydroxystearic acids, 0.7 g. of saturated acid, m.p. 57° (mainly palmitic), and a small amount of a dihydroxy-acid which melted at 127°.

Bromination of the acids (3.3 g.) of fraction L 13 yielded 0.1 g. of additive products insoluble in ether (m.p. 167°, Br 56.2%), 1.6 g. of crystalline products insoluble in light petroleum (m.p. 113°, Br 53.5%) and 4.6 g. of oily products soluble in both media (Br 43.3%). The yield of the crystalline tetrabromostearic acid (m.p. 113°) corresponds to about 24% of linoleic acid in the acids of L 13, the total content (from the I.V. 154.5) being about 70%. The amount of linolenic acid present, judged from the ether-insoluble products (0.1 g.) was very small, and could not have exceeded 1% of the mixed acids.

The acids from the residual fraction L 6, after removal of unsaponifiable matter, were submitted to lead salt-alcohol separation, when nearly 60% was recovered in the form of insoluble lead salts which gave a crystalline acid. After crystallization this melted at 32° (unchanged on admixture with an authentic specimen of erucic acid).

Table VIII. *Component acids of alcohol-insoluble phosphatide from rape seed*

	"Solid" acids S (20.2%)	"Liquid" acids L (79.8%)	Total	Component acids	
				% (wt.)	% (mol.)
Myristic	0.73	—	0.73	0.8	1.0
Palmitic	5.20	2.92	8.12	8.3	9.4
As behenic	1.47	—	1.47	1.5	1.3
Hexadecenoic	—	2.05	2.05	2.1	2.4
Oleic	4.48	17.38	21.86	22.4	23.0
Linoleic	—	41.03	41.03	42.2	43.5
Linolenic	—	Traces	Traces	Traces	Traces
Erucic	8.08	13.96	22.04	22.7	19.4
Unsaponifiable	0.24	2.46	2.70	—	—

Utilizing the above information (p. 1970), and calculating higher unsaturated acids in fraction S3 as behenic acid, the approximate composition of the component fatty acids of the alcohol-insoluble rape seed phosphatide is as given in Table VIII (p. 1970).

Alcohol-soluble phosphatide of rape seed

From the small amount of this product available (4.2 g.), only 2.6 g. of fatty acids were obtained by hydrolysis. On applying the lead salt-alcohol separation to these, 0.34 g. of "solid" acids, I.V. 42.2, was obtained, together with 2.27 g. of "liquid" acids, I.V. 129.2. The latter (in ether) were treated with bromine, and furnished a trace (0.04 g.) of ether-insoluble bromo-acid, M.P. 163°, whilst 1.2 g. of crystalline bromo-additive products (M.P. 113°, unchanged when mixed with tetrabromostearic acid, M.P. 114°) were insoluble in light petroleum.

Although it was not possible to make any further study of this material, the data obtained indicate the presence of seed-fat linoleic acid and of erucic acid in quantity, and show that, qualitatively at all events, the component fatty acids resembled those of the alcohol-insoluble group of rape seed phosphatides.

DISCUSSION AND SUMMARY

The data recorded in this paper show that the phosphatides of the two seeds studied contain a range of fatty acids qualitatively identical with those present in the corresponding glycerides. Table IX compares the quantitative data obtained for the phosphatide fatty acids with those for typical soya bean and rape seed glyceride fatty acids; several concordant analyses have been recorded for each of the latter, the figures in Table IX being respectively from recent analyses by Griffiths & Hilditch [1934] and Hilditch & Paul [1935].

Table IX. *Component acids of soya bean and rape seed glycerides and phosphatides (mol. %)*

	Soya bean			Rape seed	
	Glycerides	Phosphatides		Glycerides	Phosphatides Alcohol-insoluble
		Alcohol-insoluble	Alcohol-soluble		
Myristic	1	—	—	—	1
Palmitic	8	13	19	2	9
Stearic	5	4	—	—	—
Arachidic	Trace	1	—	—	—
As behenic	—	—	—	1	1
Hexadecenoic	*	10	6	*	2
Oleic	26	10	18	19	23
Linoleic	54	53	52	31	44
Linolenic	6	4	4	—	—
As C ₂₀ unsaturated	—	5	1	—	—
Erucic	—	—	—	47	20

* About 1% of hexadecenoic acid may also be present.

Linolenic acid is present in both glycerides and phosphatides of the soya bean, and erucic acid in those of rape seed; but the proportion of erucic acid in the phosphatide acids is much less than in the glyceride acids. It is significant, nevertheless, that in both seeds all the characteristic fatty acids of the glycerides are also found in the phosphatides. The proportion of saturated acids is, in both instances, higher in the phosphatide than in the glyceride acids. In this respect seed phosphatides seem to resemble those of animal liver fats [cf. Klenk, 1935;

Hilditch & Shorland, 1937]; but it is to be noted that in the seed phosphatides the increase is wholly in palmitic acid, whereas in the animal liver fats studied the stearic acid content increased in the phosphatides, the palmitic acid percentage being much the same as in the liver glyceride acids. This is not unnatural, however, for palmitic is the characteristic saturated acid occurring in practically every fat in the vegetable kingdom, whereas stearic acid is but rarely found as a major component acid of vegetable lipoids.

It is interesting to find hexadecenoic acid present in some quantity in the seed phosphatides, for it is present only in very small amounts in seed glycerides (data on this point will be communicated shortly elsewhere). The relative amounts of the major component unsaturated acids, oleic and linoleic, are probably the most significant in these analyses. In both seeds the ratio oleic : linoleic is markedly lower in the phosphatides than in the glycerides. It would almost seem, so far as the results in these two cases may be taken as a guide to the general behaviour, that linoleic acid is the most important component of plant phosphatide acids. In each seed it occurs to the extent of double, or more than double, the proportion of any other acid; the bromination and oxidation data establish, moreover, that it is the form of linoleic acid characteristic of seed glycerides, furnishing nearly 50 % of the crystalline tetrabromo-additive product of m.p. 114°. On the other hand, linoleic acid only forms about half of the total fatty acids. It may perhaps have a specific function in the phosphatides of seeds; but in the absence of a much wider range of information this suggestion is only speculative.

The chief results of the present study—the presence of all the characteristic seed glyceride acids in the respective seed phosphatides, and the predominance of linoleic acid—point to the need for similar detailed analyses of other seed phosphatide component acids before attempting to lay down any generalization. Our results further show that comparisons which have been made from time to time on the basis of the i.v. alone of mixed fatty acids of phosphatides and glycerides are of little value without some form of detailed analysis—at the least, a determination of the proportions of saturated acids present.

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