by ester fractionation of the concentrates may result in accurate values for the GS_3 content. It also appears likely that Kartha's revised oxidation procedure may be used satisfactorily in analysis of the fractions.

3. Cama and colleagues have compiled data showing that for a variety of seed fats the proportions of simple triglycerides found by crystallization procedures form "a remarkably regular sequence" parallel to the proportions in the whole fat of their constituent acids arranged in descending order. The simple triglycerides are of several kinds, both saturated and unsaturated. The authors indicate that the regularity of the sequence, together with the presumption that the GS_3 was accurately determined by the crystallization procedure, constitutes strong evidence that GU_3 as well as GS_3 can be accurately determined by the same method.

The fact that the sequence is regular (with a few exceptions) cannot, in this writer's opinion, be construed to mean that all the data are accurate. There is sufficient margin between individual analyses in many instances to permit gross error to exist without the fact being apparent.

4. Cama *et al.* have resolved a mixture of GS_2U, GSU_2, and GU_3 into what appear to be the concentrates from which it was prepared. These consisted of "OS_2" composed of GS_2U and GSU_2 and "OL_2" composed of GSU_2 and GU_3.

Once again, as in section one above, the composition of the mixture cannot be accepted as accurate because the ingredients were analyzed by the same method as that under examination. One would expect little difficulty in separating a mixture, into the various simpler mixtures of which it is comprised, by the same procedure used to prepare the ingredient mixtures.

It should be pointed out that although Boekenoogen *et al.* (6) recommended the use of acetic acid in the oxidation procedure in 1950, it was first disclosed by Kartha in his doctoral thesis written in 1949. The summary of the thesis was not published until 1951, which probably accounts for the misapprehension (2).

The writer is in agreement with Dr. Hilditch that Kartha's procedure should be thoroughly tested. Until this is done, neither the analytical procedure nor the theory of glyceride structure dependent upon it can be evaluated.

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December 9, 1954

Letter to the Editor

I appreciate very much the courtesy of R. J. Vander Wal, who has been so kind as to let me see his letter to you (1) prior to its publication. I regret that I do not find myself in agreement with the arguments put forward by him to show that the paper by Cama *et al.* (2) is based upon unsound premises.

1. Dr. Vander Wal questions the calculated compositions of the fat mixtures used because the "very same crystallization method" was used both in the analysis of the mixtures and of the constituents thereof. This is surely an overstatement: the components of the mixtures were relatively simple compared with the complex mixtures of these which were employed. The application of the same general technique to glyceride mixtures of such widely varying build is, in my opinion, no valid objection to the argument. Rather, if the crystallization procedure were as inaccurate as Dr. Kartha has asserted, it would require an extreme series of coincidences to result in any accordant results being obtained in the experiments described by Cama *et al.*

2. Dr. Vander Wal further rules out any of the data in which trisaturated glycerides were at any stage of the "crystallization" procedure determined by our procedure of oxidation, which Dr. Kartha (3) alleged to be inaccurate. I have so far seen no reason to accept Dr. Kartha's criticisms and am satisfied that any advantage in his preferred oxidation procedure is confined to relatively slight, if any, alterations in the determined proportions of trisaturated glycerides.

3. Dr. Vander Wal "readily concedes that low temperature fractionation followed by ester-fractionation of the concentrates may result in accurate values for the GS_3 content." In this he appears to differ from Dr. Kartha, who has condemned the crystallization procedure and who (4) announced his failure to separate by crystallization a very simple mixture of oleodistearin and triunsaturated glycerides.

As mentioned in my previous letter to your Journal (5), a very large number of natural fats have now been examined by the "crystallization" procedure, and it is now possible to plot graphs of the contents of glycerides containing one, two, or three groups of a variety of acids (saturated, oleic, linoleic, linolenic, elaeostearic, ricinoleic, and several others). Whatever acid may be considered, the experimentally found points of glycerides containing one, two, or three of its groups are distributed about curves which are of precisely the same shape for each individual acid and can indeed be superimposed. The content of glycerides containing one group of a particular acid reaches a maximum (85-90%) when that acid forms exactly one-third of the total acids, and the content of glycerides containing two groups of the acid reaches a similar maximum when the acid forms exactly two-thirds of the total acids. Since my previous letter was written, typical curves of this kind have been published (6); a completely detailed account of glyceride structure as revealed by the "crystallization" procedure used by my associates and by other workers (which is too lengthy to be dealt with in a communication to a scientific journal) will appear in due course in a book of mine now in the printer's hands.

I regret that Dr. Vander Wal has not considered in his letter two criticisms of Dr. Kartha's work which I made (5) and which appear to me to demand serious attention:

1. According to Kartha's data obtained by his "revised oxidation procedure" for 23 natural fats (rang-

ing from 8 to 61% of saturated acids in the total acids), disaturated glycerides may form over 80% of a fat whereas diunsaturated glycerides never exceed 45-50%; conversely monounsaturated glycerides may form over 80%, but monosaturated glycerides never more than 45-50% of a natural fat. Hence, according to Kartha, saturated and unsaturated acids behave entirely differently as regards their distribution in mixed glycerides.

As stated above, no such difference is exposed in studies of fats made by the modern crystallization techniques. What the latter have revealed is that each acid plays an individual part in its distribution in mixed glycerides, that therefore (although no difference in general behavior exists between one acid and another) it is necessary to consider each acid separately, and that it is not sufficient to consider acids in groups (*e. g.*, saturated and unsaturated). Such collective treatment ("GS_3," "GS_2U," etc.) was all that was possible 20 years or so ago, but the later advances in low-temperature crystallization have made it somewhat out of date.

2. In my experience the danger of hydrolysis of azelao-glyceride products of oxidation is likely to operate to the greatest extent during the removal of these from neutral (trisaturated) glycerides when considerable emulsification and interfacial dispersion of the azelao-glycerides takes place. Hydrolysis is more probable at this stage than in the actual oxidation in acetone solution. Will Dr. Vander Wal or Dr. Kartha explain how the presence of acetic acid in the acetone solution during oxidation protects the azelao-glycerides from hydrolysis in the slightly alkaline emulsions produced during their subsequent removal?

Finally, Dr. Vander Wal agrees with me (5) that Kartha's procedure (and also, I feel, the crystallization technique) should receive scrutiny from independent workers in this field. Actually, before my previous letter appeared in the Journal, Luddy, Fertsch, and Riemenschneider (7) had published the results of a study of four fats by both methods. The results were "in fair agreement for lard, chicken fat and cottonseed oil, but not for palm oil." The calculated values for glyceride distribution according to patterns either of random distribution or of distribution on Kartha's hypothesis "however did not agree well with those obtained experimentally by either method, except for one of the four fats, chicken fat."

If the glyceride distribution of natural fats is of any worthwhile interest or value, it is earnestly to be hoped that further work on the lines indicated by Luddy *et al.* will be pursued by them and also by other independent investigators in regard both to Kartha's oxidation procedure and to resolution by crystallization (the latter, of course, as in the work of Luddy *et al.*, carried out on a rational and intensive basis).

As Dr. Vander Wal says, until Kartha's procedure has been thoroughly tested, the theory of glyceride structure dependent upon it cannot be evaluated. For my part, I should be most surprised to find that the whole range of natural fats, so varied in composition and structure, can ever be brought within the scope of a single formula of computation, so mechanical as that proposed by Dr. Kartha. But in my opinion little will result by consuming further time in criticism from one side or the other. Let the facts be ascertained by further scrutiny from competent investigators. The modern "crystallization" techniques will be justified by the results and will doubtless, during the process, be found capable of further development and improvement.

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January 31, 1955

ABSTRACTS . . . . . R. A. Reiners, Editor

• Oils and Fats

Ralph W. Planck, Abstractor
Dorothy M. Rathmann, Abstractor
Sin'itiro Kawamura, Abstractor

The branched-chain fatty acids of butterfat. 6. Further investigations on the C_{15} saturated acids. F. B. Shorland, T. Gerson, and R. P. Hansen(Fats Res. Lab., Dept. of Scientific and Ind. Res., Wellington, New Zealand). *Biochem. J.* **59**, 350-2(1955). Two C_{15} branched-chain acids, (+)-12-methyltetradecanoic acid and 13-methyltetradecanoic acid, together with *n*-pentadecanoic acid, have been isolated from butterfat by methods which did not involve hydrogenation. Expressed as a percentage of the total fatty acids, the amounts of (+)-12-methyltetradecanoic acid, 13-methyltetradecanoic acid and *n*-pentadecanoic acid were 0.43, 0.37 and 0.82 per cent, respectively.

The absorption of aliphatic acids from aqueous solution by porous carbons. J. L. Morrison and D. M. Miller(Dept. of Chem., Univ. of Alberta, Edmonton, Alberta). *Can. J. Chem.* **33**, 330-343(1955). The maximum adsorptions of the lower members of the mono- and di-carboxylic acids from aqueous solutions were determined for coconut charcoals of different degrees of activation. Based on these results, a method for estimating pore size was applied to the more finely porous charcoals. An alternation in the maximum amounts of adsorbed acids was observed with the more active charcoals. Acids with an even number of carbon atoms had larger adsorptions than acids with an odd number. The alternation was much more marked for the di- than for the mono-carboxylic acids. A remarkable correlation between the alternation of absorptions and of melting points of both acid series was observed. The explanation offered is based on rotational motion of molecules in the solid state as against the widely held explanation based on tilting of molecular chains.

Lipids of the female reproductive organs in Ascaris lumbricoides. D. Fairbairn(McGill Univ., Macdonald College, Que.). *Can. J. Biochem. & Physiol.* **33**, 31-7(1955). The female reproductive organs of *Ascaris lumbricoides* represented one-fifth of the total fresh weight and contained two-thirds of the total body lipids. These lipids consisted of saponifiables(79%) and unsaponifiables (21%). Phospholipids of the lecithin-cephalin type were present, as well as an abundance of triglycerides. The latter contained unusually large amounts of C_2-C_8 saturated volatile acids among which acetic and hexanoic acid predominated. Ascaryl alcohol was the major constituent of the large unsaponifiable fraction, and on the basis of previous chemical