Letters to the Editor.

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The Sources of Supply of Vitamins A and D.

THE problem of an adequate supply of the fat-soluble vitamins for the needs of the growing population has received prominent attention at the recent meeting of the British Association. The shortage in the supply of milk fat in particular was emphasised, and a simple calculation led to the conclusion that this shortage is not a local one in Great Britain, but of world-wide extent. Butter is irreplaceable by margarine as long as this article of diet is deficient in vitamins. Even if we do not share the gloomy view as to the effect of this shortage on the health of the nation, since milk fat is not their only source, it must be admitted that the problem of the supply of fat-soluble vitamins is of outstanding importance.

We would like to direct attention to the outcome of recent researches, only partially published as yet, in the course of which we became aware of easily accessible sources of both vitamins A and D. The solution of the problem depends now only on the industrial application of the knowledge made available by such research.

So far as vitamin A is concerned, we found that the chromogen responsible for the arsenious chloride colour reaction, discovered by one of us (O. R.), is present not only in the liver of the cod, but also in the livers of all animals examined, fishes, birds, and mammals. A study of the quantitative distribution of this chromogen and its correlation with vitamin A by means of the biological growth-test (*Lancet*, ii. 806; 1926), proved that the amount present in other liver fats in many cases far exceeds that found in cod-liver oil, the richest source of vitamin A previously known. It must be remembered that the main reason for the selection of the cod as a source of medicinal oil, leading to the development of the cod-liver oil industry, was the extraordinarily high fat content of the cod's liver and its relatively easy extraction on a commercial scale. As regards vitamin A content, however, we found that the liver oils of other fishes, such as salmon or halibut, are often more than 100 times as rich as cod-liver oil.

On account of their limited accessibility, these oils cannot be considered as a commercial source of vitamin. The same reason excludes the liver fats of birds, some of which, such as those of the grouse, goose, fulmar petrel (*Biochem. Jour.*, 111; 1927), are extremely potent. The liver fats of herbivorous mammals, on the other hand, appear to be an ideal source of vitamin A. These animals live mainly on green fodder, the original source of vitamin A, and accumulate a store of it in the liver, as do fish and birds. We found by both colorimetric and biological tests that the liver fats of sheep, calf, and ox contain on the average as much as ten times the amount of vitamin A as a good Newfoundland cod-liver oil. Taking the vitamin A content of butter—a very variable factor—as from 1/20 to 1/100 that of cod-liver oil, these fats may be said to be from 200 to 1000 times more potent in this respect than butter. A recently published letter (see *Times*, Sept. 7) shows that by an interesting coincidence our results in this respect are confirmed by the independent observations, hitherto not published in detail, of Prof. Wilson, formerly of Cairo. According to these, "the liver fats of Egyptian

sheep and oxen appear to contain about 200 times the amount of vitamin A found in the best butter examined." Without entering into a calculation of the available supply of liver, we may assume that Great Britain's need is easily met at home, supplemented if necessary by Empire produce. It may be stated that the vitamin content of the fat obtained from imported New Zealand liver equalled that of the liver of home-killed animals.

As an additional advantage for the purpose suggested, we find that these fats are free from the objectionable flavour of fish oils, which is apparently connected with the presence of the highly unsaturated elupanodonic acid ($C_{22}H_{34}O_2$) and the Fearon colour reaction (*Biochem. Jour.*, 1342; 1926). Owing to their low melting-point, liver fats can be easily incorporated with other fats, such as margarine. Although easily extracted by the use of fat solvents, their isolation would probably not be necessary in large scale manufacture. Vitamin A, being fat-soluble, can be directly extracted from the tissue by a neutral oil. The well-known skill of the margarine manufacturer should enable him so to incorporate the liver fats with his product as to convert a dietary article, already identical with butter in calorific value, into a cheap and palatable product of equal biological efficiency, so far as vitamin A is concerned.

The no less important vitamin D, another variable constituent of butter, remains to be considered. Contrary to the expectation that this would also be contained in the mammalian liver fat, we found that the liver fat of sheep, at any rate, is practically devoid of this vitamin. It would seem that, unlike fish, the herbivorous mammal does not store vitamin D in the liver. On the other hand, the body fats of certain fishes, although free from vitamin A, as tested both colorimetrically and biologically, were found to be a good source of vitamin D. An interesting exception to what appears to be a general rule was revealed in the examination of the body oil obtained from eels. The oil content of this fish is relatively high (about 30 per cent.), and it contains not only vitamin D, but also vitamin A in an amount nearly equal to that of some Norwegian cod-liver oils (tested colorimetrically and controlled by the animal test). This result confirms, incidentally, the high value empirically attributed to the eel as an article of diet.

There is, however, no need to search any longer for a natural source of vitamin D, since we are now able to produce this important vitamin artificially by irradiation of ergosterol (*Biochem. Jour.*, 389; 1927). Irradiated ergosterol possesses extraordinarily potent anti-rachitic activity, 1/10,000-1/20,000 mgm. per diem preventing and curing rickets in rats. Clinical experience has since shown that human rickets also is rapidly cured by daily doses of 2-4 mgm. The amount to be incorporated with margarine need, therefore, be only extremely small. By a study of the best conditions of its formation in yeast, a practically unlimited supply of ergosterol should be available for this purpose.

The margarine manufacturers have therefore at their disposal, if they care to make use of them, means which should make a perfect biological substitute for butter accessible, without unduly raising the price of margarine. Moreover, by carefully controlled methods of manufacture, it should be possible to supply a product of constant vitamin content, superior in this respect to natural butter, the vitamin content of which depends on too many uncontrollable factors of the food supply of the cow.

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