"NON-FATTENING FAT" FROM RAPESEED OIL

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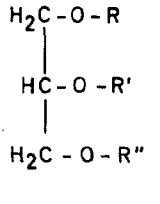
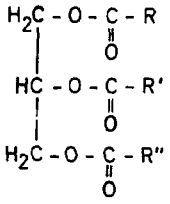
Introduction

The population of most industrialized countries is overfed and therefore particularly susceptible to certain diseases (BANSI, 1965). Hence, it appears desirable to reduce the consumption of fat, which is the most caloric constituent of food. This could possibly be accomplished by substituting part of the dietary fat by lipids which cannot be absorbed by the organism (MERTEN, 1970). Such "non-fattening fats" are, for example, the trialkylglycerols (I), substances whose structure resembles that of the triacylglycerols (II), the major constituents of the edible fats and oils.



(I)
Trialkylglycerols



(II)
Triacylglycerols
(Triglycerides, "Fats")

So far, trialkylglycerols have not been found in nature, but they have been obtained by chemical synthesis (BAUMANN and MANGOLD, 1966; PALTAUF and SPENER, 1968).

It is well known that long-chain trialkylglycerols fed to rats (SPENER et al., 1968; MORGAN and HOFMANN, 1970) and pigs (CARLSON and BAYLEY, 1968, 1972) are neither cleaved in the alimentary canal of the animals, nor are these compounds absorbed intact (SPENER et al., 1968; MORGAN and HOFMANN, 1970; CARLSON and BAYLEY, 1968, 1972); they are rather excreted with the feces (SPENER et al., 1968; CARLSON and BAYLEY, 1972). When supplied with the diet, the trialkylglycerols do not influence the absorption of fats and fat-soluble vitamins (MORGAN and HOFMANN, 1970).

These findings are the results of studies that have been carried out using

small amounts of radioactively labelled trialkylglycerols. Provided trialkylglycerols can be produced on an industrial scale, it should be possible to use these compounds in fatty food as a constituent having no caloric value (MANGOLD, 1972).

The objectives of the present investigation were: Firstly, to develop a method for the synthesis of trialkylglycerols on a large scale; secondly, to test whether relatively large amounts of dietary trialkylglycerols cause any ill-effects in the rat, and thirdly, to determine whether their inclusion in the diet indeed effects the expected reduction in weight gain of the animals.

Material and methods

The trialkylglycerols of rapeseed oil as well as those of soybean oil were reduced to long-chain alcohols (BROWN, 1951) and these were converted to alkylmethanesulfonates (BAUMANN and MANGOLD, 1964). The reaction of the alkylmethanesulfonates with isopropylideneglycerol followed by hydrolytic cleavage of the isopropylidene group led to asymmetrical alkylglycerols (BAUMANN and MANGOLD, 1964). Alkylation of the alkylglycerols afforded mixtures of trialkylglycerols (BAUMANN and MANGOLD, 1966). The overall yield of this sequence of reactions (Scheme 1) was about 25 %.

The trialkylglycerols prepared from rapeseed oil as well as those derived from soybean oil were colorless, flavorless and tasteless liquids. The alkyl moieties in these trialkylglycerols corresponded to the acyl moieties in the triacylglycerols from which they were derived, both with respect to chain-length and number and configuration of double bonds.

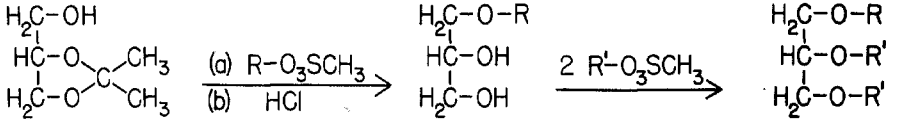
The two samples of synthetic trialkylglycerols were mixed with soybean oil in a 1:1 ratio, and these mixtures were fed to two groups of six rats, each. The animals of these two experimental groups received by stomach tube 200 mg per animal, per day, of the respective mixtures. After nine days they were fed 200 mg of pure soybean oil, per animal, per day. Six rats of a control group received 200 mg of pure soybean oil throughout the experiment, i.e., for 16 days. The animals of the three groups had free access to standard "lab chow" and water throughout the 16 days of the feeding experiment.

Results and discussion

We have found that both the alkylation of the sodium or potassium salts of glycerol with alkylhalides or alkylmethanesulfonates, and the reaction of trichloropropane or trimesyloxypropane with sodium or potassium alcoholates afford the trialkylglycerols in very low yields (CEGLA, 1974). Thus, we have prepared numerous individual trialkylglycerols by alkylating symmetrical and asymmetrical alkylglycerols and dialkylglycerols (CEGLA, 1974). We consider the route of synthesis shown in Scheme 1 to be the most efficient: A salt of isopropylidenegycerol is reacted with an alkylmethane-

sulfonate, the resulting isopropylidenealkylglycerol is treated with mineral acid to remove the protecting isopropylidene group, and the asymmetrical alkylglycerol thus obtained is further alkylated with alkylmethanesulfonate.

Scheme 1: Synthesis of trialkylglycerols (BAUMANN and MANGOLD, 1966)



(I)

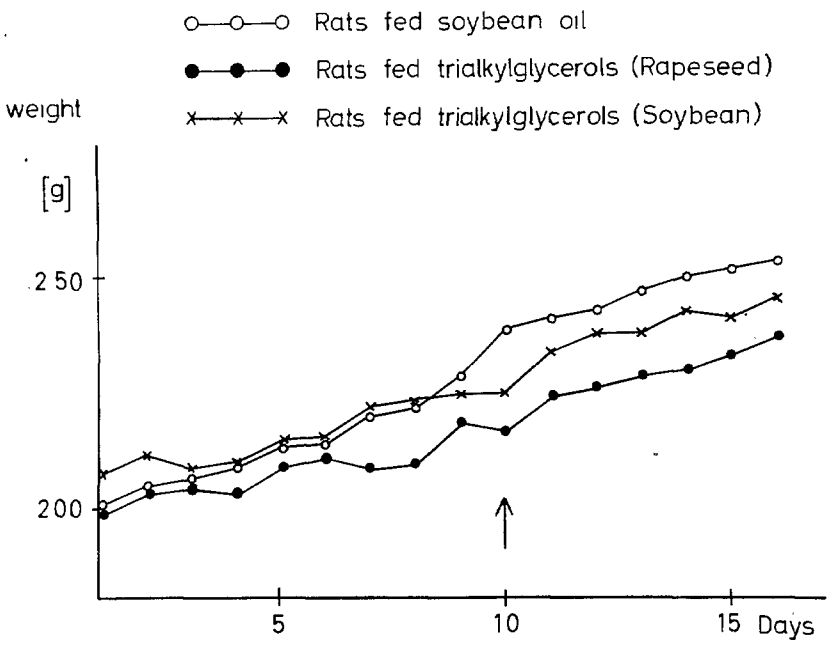
The isopropylideneglycerol needed as starting material is easily accessible and the alkylmethanesulfonates used as alkylating agents can also be obtained in excellent yields. Thus, we synthesized mixtures of trialkylglycerols both from rapeseed oil and from soybean oil via the alcohols, alkylmethanesulfonates and alkylglycerols.

The rats which received mixtures of trialkylglycerols and soybean oil did not show any sign of ill-effects, not even diarrhoea (REICHWALD, 1974). None of the animals died during the experiment. On autopsy, no difference could be found between the appearance of organs of the animals in the experimental groups and those of the control animals (REICHWALD, 1974).

The rats of the two experimental groups and of the control group consumed about the same amount of the basic diet, but rats which had received a mixture of trialkylglycerols and soybean oil gained weight at a much slower rate than those which had received pure soybean oil (REICHWALD, 1974). This finding is evident from Figure 1.

On the average, during the first 9 days, the rats that received a mixture of trialkylglycerols derived from rapeseed oil with soybean oil gained 2.1 g per animal, per day. Those which were fed a mixture of trialkylglycerols derived from soybean oil with soybean oil gained 1.8 g per animal, per day. Animals of the control group, however, gained 3.1 g of weight per animal, per day. In the second part of the experiment, when the rats of the two experimental groups received soybean oil, they gained weight at a rate of 2.9 g and 2.4 g, respectively, per animal, per day. The results of these nutritional studies demonstrate that the average weight gain of rats is about 30 % lower if half of the dietary fat is replaced by trialkylglycerols.

Figure 1: Average weight gain of rats fed trialkylglycerols



In conclusion we can state that low caloric dietary fat can be made by blending the common fats and oils with trialkylglycerols derived from these natural products by chemical synthesis. The yields of the various synthetic routes, however, are still unsatisfactory. Moreover, feeding experiments in man are yet to be done.

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