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THE RELATIVE VALUES OF ANIMAL AND VEGETABLE FATS IN NUTRITION

Chairman: PROFESSOR A. C. FRAZER, Ph.D., D.Sc., M.D., *Department of Medical Biochemistry and Pharmacology, University of Birmingham*

Animal and vegetable fats: Chairman's opening remarks

By A. C. FRAZER, *Department of Medical Biochemistry and Pharmacology, University of Birmingham*

The effect of dietary fats on the body has been the subject of much discussion in recent years. The problems are complex and, in opening this Symposium, it might be useful to consider briefly some of the dangers of oversimplification in this field.

First, generalizations about animal and vegetable fats may suggest that the origin of the fat determines some particular properties. Some vegetable fats, especially seed fats, contain rather large amounts of unsaturated fatty acids, such as linoleic acid. There are, however, many vegetable fats that do not. Again, some animal fats may be relatively saturated; this is particularly true of the depot fats of ruminant animals, partly owing to extensive hydrogenation of unsaturated dietary fatty acids in the rumen and partly because much of the depot fat may be synthesized from carbohydrate sources. However, some animal fats, such as pig depot fat, may contain large amounts of linoleic acid, if it is present in the diet given to the animal. Fish fats also contain large amounts of highly unsaturated fatty acids. The animal or vegetable origin of a fat is, thus, relatively unimportant; the essential information required is its chemical composition.

Second, from the chemical point of view, it is not sufficient to describe fats in terms of their content of saturated or unsaturated fatty acids. The length of the carbon chain, the number of double bonds, their situation in the carbon chain, their position relative to each other and the occurrence of *cis* or *trans* configuration are points of importance in considering the biological properties of a fatty acid. The proportions of the different types of fatty acid and the presence of other components in the molecule may also be significant. It is essential to give full information on the chemical structure of all lipids studied.

Third, fats in the raw state may differ from those consumed because of processes such as low-temperature filtration or hydrogenation, applied to the fat to make it more suitable for dietary use. Fats chosen for experimental studies should conform to appropriate specifications; otherwise important variations in composition may pass unnoticed. The fat occurring in food materials may be incidentally affected by processes used for other purposes.

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Apart from industrial processes, fats may be subjected to various forms of treatment, such as repeated cooling and heating, at the domestic level. Heating is usually carried out under conditions that favour oxidation. Heating and oxidation of fats may result in chemical changes, such as the formation of hydroperoxides, polymers and secondary oxidation products, which may be accompanied by changes in physical properties, such as increase in viscosity or altered solubility. Toxic effects and even cancer production have been attributed to the consumption of heated and oxidized fats. However, the carcinogenic effect is not satisfactorily established at the present time. Oxidized fats may destroy certain vitamins in the food; this effect may occur in the gastro-intestinal tract, as well as in stored food materials. It is apparent that care must be taken to guard against or control deteriorative effects resulting from heating or oxidation of fats. This is particularly important in long-term feeding studies.

Fourth, many natural fats contain lipid-soluble molecules, such as natural anti-oxidants, sterols, or phosphatides. Processed fats may contain synthetic anti-oxidants or other additives. Under certain circumstances, fats may become contaminated with a carcinogenic agent, such as 3,4-benzpyrene. It is apparent that many of these substances might significantly affect the chemical behaviour of the fat or the results of studies on the biological properties of the fat containing them. The nature and quantity of contaminants or impurities in the fat studied must be known.

Fifth, fats may undergo changes in the intestinal lumen or in the tissues during the course of absorption and transport. Glycerides are partially hydrolysed by pancreatic lipase, which preferentially liberates fatty acids attached to the α-carbons of the glycerol. The intestinal flora may hydrogenate fats either in the rumen in animals, as already mentioned, or in the human intestine under certain circumstances. The flora may cause a number of other modifications in structure, such as the formation of hydroxy fatty acids. Long-chain fatty acids, containing more than ten carbons, are readily incorporated into re-formed triglycerides in the intestinal mucosa, whereas shorter-chain fatty acids are not. This differentiation may affect the pathway of absorption, the short-chain fatty acids passing into the portal blood, whereas the long-chain compounds are found mainly in the chyle. Unsaturated fatty acids appear to be preferentially esterified with cholesterol; the various phosphatides may also have a preferred fatty-acid pattern. Thus, the chemical structure of a fat may affect its eventual distribution and use in the body, and modifications in structure may occur in the course of digestion, absorption and transport.

Sixth, having taken all appropriate precautions, it may be possible to demonstrate that a certain fat has some particular effect on the body. For example, the administration of *cis,cis*-linoleic acid to human subjects with hypercholesterolaemia may cause a reduction in the blood cholesterol level. However, this does not indicate either that a dietary deficiency of linoleic acid will cause hypercholesterolaemia, or that subjects with hypercholesterolaemia are suffering from linoleic-acid deficiency. The demonstration of a correlation between two observations does not in itself indicate any causal relationship. Much more information is needed before differentiation can be made between cause and effect.