

Food Microscopy (An Annotated Bibliography)

PART IID. MAJOR INGREDIENTS: FATS AND OILS

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Fats and oils occur in natural foods and also constitute one of the major ingredients in many manufactured foods, including baking products, confectionery, dairy products, margarine and many other different types of "spread".

The main sources of edible fats and oils are vegetable fats (~49 per cent.), animal fats (~46 per cent.) and marine oils (~5 per cent.). Vegetable fats and oils are obtained from the appropriate seeds and fruits either by mechanical expression or solvent extraction. The crude oil so obtained is then neutralised, bleached and deodorised. Animal fats, such as beef fat, mutton fat and lard are obtained by rendering the fatty tissues of the animals. In addition to these basic methods of manufacture, many different processing methods are used to alter the basic properties of fats. These processing methods may alter the *chemical composition* as in (a) blending, (b) hydrogenation, (c) interesterification, (d) glycerolysis and (e) fractionation or may profoundly affect the *physical form* or crystal structure of the fat as in (f) solidification, (g) tempering and (h) ageing or storage.

Microscopical studies have been carried out on bulk fats, on fats in emulsions or as powders, and on fats in more complex products, where it is necessary to show their presence by the use of histochemical reagents, normal stains or fluorescent stains. The microscopical properties which can be studied in bulk fats include crystal habit, size and extent of aggregation, inclusions, the effects of reagents, thermal properties, polymorphism and the effects of composition and processing on their microstructure. Some early workers have used crystal habit to detect the adulteration of lard with beef fat, but the method is not altogether reliable. Studies have been carried out on crystal size in fats; the production of very fine crystals is favoured by a high rate of nuclei formation coupled with a low linear crystallisation velocity. The extent of aggregation and network formation in fats is a vital factor controlling their rheological properties, and is an aspect arousing increasing interest. Apart from crystals, other "inclusions" in fats that have been studied microscopically are air bubbles (plasticised fats) and water droplets (butter and margarine). Some attempts have been made, in chemical microscopy, to use the saponifica-

tion reaction and also the formation of fatty acid crystals as a diagnostic tool for fat identification, but these methods are very limited.

Thermal properties of fats that can be studied with a microscope hot-stage include melting points, refractive index of the melt, supercooling and crystallisation behaviour. Many fatty acids and glycerides show the phenomenon of multiple melting points on heating, due to polymorphism—the occurrence of more than one crystalline form. Considerable work has been done in this field with the polarising microscope and hot-stage, used in conjunction with other methods such as cooling and heating curves, dilatometry, X-ray diffraction, infrared spectroscopy and nuclear magnetic resonance. Generally, the triglycerides show 4 polymorphic forms (α , β' , β'' and β), but in some cases (e.g. cocoa butter) up to 6 forms have been found. Another thermal parameter, which has some advantages over the melting point, is the critical mixing temperature (CMT) or critical solution temperature (CST); the sample and a test liquid are introduced into a capillary which is heated on a micro hot-stage, and the CMT is the temperature at which the meniscus between the two liquids disappears. The method is said to be diagnostic.

The crystalline characteristics of fats can be modified either by altering their molecular composition or by variation of their physical processing, and microscopical studies in both areas have been reported. Where processing is concerned, many studies have been made, over the last ten years, of the process for the production of quick-tempered shortenings, using scraped-surface heat exchangers. The relationship between rheological properties and microstructure is of considerable practical importance.

Fats and oils are also met with in the form of oil-in-water emulsions, as in cream, ice cream, salad dressings, milk, etc., and in the form of water-in-oil emulsions as in butter and margarine. The microscope is extensively used in measuring the size of the globules in such emulsions, and in the study of their stability to heating and cooling, freezing and thawing. Supercooling in the oil phase of oil-in-water emulsions is also of practical importance and has been studied microscopically.

Free-flowing powdered fats have been made by spray-setting and by spray-drying of oil-in-water emulsions, and the microscope can be used to study their particle size and size distribution, particle shape and air inclusions.

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