RAMSADAY COLLEGE

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Department: BOTANY

Teacher: Dr. Arnab Kr. De

Caption: e-Material of BOT-A-CC-4-9-TH

Oils and fats: General description, classification, extraction, their uses and health implication of mustard, soybean, coconut (Botanical name, family and uses).

General description of fats and oils

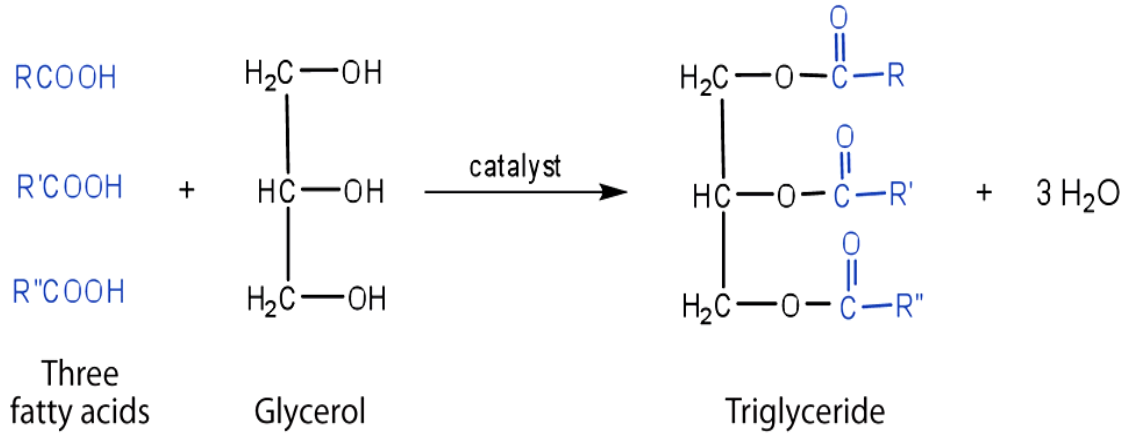
Fats and oils are the most abundant lipids in nature. They provide energy for living organisms, insulate body organs, and transport fat-soluble vitamins through the blood. Fat is defined as one of the three main macro-nutrients: fat, carbohydrate, and protein. Fats are a wide group of compounds whose basis is in long-chain organic acids, called fatty acids. More particularly fats are esters of such organic acids formed with the alcohol glycerol. Glycerol is a triol, meaning that it has three chemically active -OH (hydroxyl) groups.

Oil is the term usually used to refer to fats that are liquids at normal room temperature, while fat is usually used to refer to fats that are solids at normal room temperature.

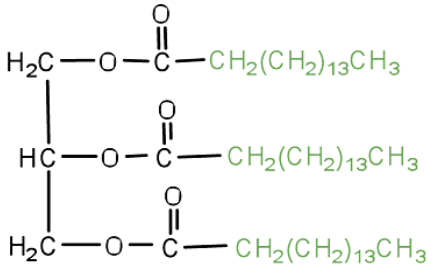
It is these fatty acids that give the functionality to fats. Chemically, they can be divided into four main types – saturated, *cis*-monounsaturated, *cis*-polyunsaturated and *trans* fatty acids. In very broad terms, saturated fatty acids and *trans* fatty acids are solid at room temperature while the *cis*-unsaturates are liquid at room temperature.

Structures of Fats and Oils

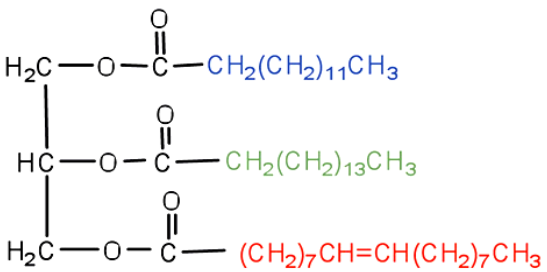
Fats and oils are called triglycerides (or *triacylcylgerols*) because they are esters composed of three fatty acid units joined to *glycerol*, a trihydroxy alcohol:



If all three OH groups on the glycerol molecule are esterified with the same fatty acid, the resulting ester is called a *simple triglyceride*. Although simple triglycerides have been synthesized in the laboratory, they rarely occur in nature. Instead, a typical triglyceride obtained from naturally occurring fats and oils contains two or three different fatty acid components and is thus termed a *mixed triglyceride*.



Tristearin
a simple triglyceride



a mixed triglyceride

A triglyceride is called a fat if it is a solid at 25°C; it is called an oil if it is a liquid at that temperature. These differences in melting points reflect differences in the degree of unsaturation and number of carbon atoms in the constituent fatty acids. Triglycerides obtained from animal sources are usually solids, while those of plant origin are generally oils. Therefore, we commonly speak of animal fats and vegetable oils.

No single formula can be written to represent the naturally occurring fats and oils because they are highly complex mixtures of triglycerides in which many different fatty acids are represented. Table 17.2 "Average Fatty Acid Composition of Some Common Fats and Oils (%)*" shows the fatty acid compositions of some common fats and oils. The composition of any given fat or oil can vary depending on the plant or animal species it comes from as well as on dietetic and climatic factors. To cite just one example, lard from corn-fed hogs is more highly saturated than lard from peanut-fed hogs. Palmitic acid is the most abundant of the saturated fatty acids, while oleic acid is the most abundant unsaturated fatty acid.

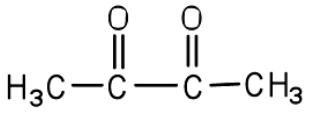
Table 17.2 Average Fatty Acid Composition of Some Common Fats and Oils (%)*

	Lauric	**Myristic**	**Palmitic**	**Stearic**	**Oleic**	**Linoleic**	**Linolenic**
Fats							
butter (cow)	3	11	27	12	29	2	1
tallow		3	24	19	43	3	1
lard		2	26	14	44	10	
Oils							
canola oil			4	2	62	22	10
coconut oil†	47	18	9	3	6	2	
corn oil			11	2	28	58	1
olive oil			13	3	71	10	1
peanut oil			11	2	48	32	
soybean oil			11	4	24	54	7
***Totals less than 100% indicate the presence of fatty acids with fewer than 12 carbon atoms or more than 18 carbon atoms.**							
†Coconut oil is highly saturated. It contains an unusually high percentage of the low-melting C_8, C_{10}, and C_{12} saturated fatty acids.							

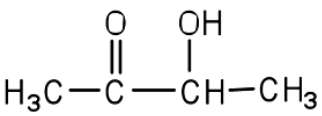
Terms such as *saturated fat* or *unsaturated oil* are often used to describe the fats or oils obtained from foods. Saturated fats contain a high proportion of saturated fatty acids, while unsaturated oils contain a high proportion of unsaturated fatty acids. The high consumption of saturated fats is a factor, along with the high consumption of cholesterol, in increased risks of heart disease.

Physical Properties of Fats and Oils

Contrary to what you might expect, *pure* fats and oils are colorless, odorless, and tasteless. The characteristic colors, odors, and flavors that we associate with some of them are imparted by foreign substances that are lipid soluble and have been absorbed by these lipids. For example, the yellow color of butter is due to the presence of the pigment carotene; the taste of butter comes from two compounds—diacetyl and 3-hydroxy-2-butanone—produced by bacteria in the ripening cream from which the butter is made.



Diacetyl



3-hydroxy-2-butanone

Fats and oils are lighter than water, having densities of about 0.8 g/cm^3. They are poor conductors of heat and electricity and therefore serve as excellent insulators for the body, slowing the loss of heat through the skin.

Classification of fats

Fatty acids can be grouped into four main types:

- Saturated
- Monounsaturated
- Polyunsaturated
- Trans

Saturated fatty acids are straight chains of carbon atoms consisting of methylene (CH2) groups between the end methyl and carboxylic acid groups. The most common saturated fatty acids are lauric acid (C12), palmitic acid (C16) and stearic acid (C18). Shorter chain saturated fatty acids are found in butterfat (e.g. C4, butyric acid) and coconut oil (e.g. C8, caprylic acid, and C10, capric acid).

Monounsaturated fatty acids contain a single carbon-carbon double bond in the carbon chain. This is usually in the *cis* configuration. The most common monounsaturated fatty acid is oleic acid, containing 18 carbon atoms. In oleic acid, the double bond is between carbon atoms 9 and 10 (counting from the COOH group)

Polyunsaturated fatty acids have more than one double bond in the carbon chain. Common polyunsaturated fatty acids are linoleic acid (18 carbon atoms and 2 double bonds between carbon atoms 9/10 and 12/13) and linolenic acid (18 carbon atoms and 3 double bonds between carbon atoms 9/10, 12/13 and 15/16).

Trans fatty acids: It is, of course, possible to count the position of these double bonds from the other end of the chain, the methyl group end. In these two examples, the first double bond to be encountered in linoleic acid is at the sixth carbon atom and, for this reason, linoleic acid is also called an omega-6 polyunsaturate. In linolenic acid, the first double bond is at the third carbon atom and so linolenic acid is called an omega-3 polyunsaturate.
The fourth type of fatty acid, *trans* fatty acids, are also unsaturated but, in this case, some or all of the double bonds are in the *trans* configuration.

Classification of oils

There are three categories of fatty oils:

1. Drying and semi-drying oils,
2. Non-drying oils, and
3. Vegetable oils.
4.

The refined grades of drying and semi-drying oils are used as edible oils, whereas the inferior grades are used in making soaps, varnishes, paints candle and other such articles.
The non-drying oils are edible and can be used for soap and lubricants.
The fats are solid or semi-solid at ordinary temperatures. They are edible and are also used in the soap and candle industries.

Extraction and processing of fatty Oils

Extraction of Oils:

The oil and fat products used for edible purposes can be divided into two distinct classes: liquid oils, such as olive oil, peanut oil, soybean oil, or sunflower oil; and plastic fats, such as lard, shortening, butter, and margarine. The physical nature of the fatty material is unimportant for some uses, but the consistency is a matter of consequence for other products. As a dressing on green salads, for example, a liquid oil is used to provide a coating on the ingredients; a plastic fat such as lard or butter would be unsuitable. Spreads for bread, foods that require a highly developed dough structure, or icings and fillings with a plastic structure require plastic fats rather than liquid oils.

- Most oilseeds are grown specifically for processing to oils and protein meals, but several important vegetable oils are obtained from by-product raw materials.
- Fats may be recovered from oil-bearing tissues by three general methods, with varying degrees of mechanical simplicity:
  (1) rendering,
  (2) pressing with mechanical presses, and
  (3) extracting with volatile solvents.

1) **Rendering:**
   The crudest method of rendering oil from oleaginous fruits, still practiced in some countries, consists of heaping them in piles, exposing them to the sun, and collecting the oil that exudes. In a somewhat improved form, this process is used in the preparation of palm oil; the fresh palm fruits are boiled in water, and the oil is skimmed from the surface. Such processes can be used only with seeds or fruits (such as olive and palm) that contain large quantities of easily released fatty matter.
2) **Pressing with mechanical presses:**
   With many oil-bearing seeds and nuts, rendering will not liberate the oil from the cellular structures in which it is held (see Figure 2). In these cases the cell walls are broken by grinding, flaking, rolling, or pressing under high pressures to liberate the oil. The general sequence of modern operations in pressing oilseeds and nuts is as follows: (1) the seeds are passed over magnetic separators to remove any stray bits of metal; (2) if necessary, the shells or hulls are removed; (3) the kernels or meats are converted to coarse meal by grinding them between grooved rollers or with special types of hammer mills; and (4) they are pressed in hydraulic or screw presses with or without preliminary heating, depending on the type of oil-bearing material and the quality of oil desired. Oil expressed without heating contains the least amount of impurities and is often of edible quality without refining or further processing.
3) **Extracting with volatile solvents:**
   For seeds or nuts containing a higher oil content than soybeans it became customary to press the material in screw presses to remove a large proportion of the oil before extraction. Since this prepressing also ruptures the cellular structures of oil-bearing materials, most of the residual oil is easily removed with solvents. A typical extraction system consists of
   (1) cleaning to remove tramp iron, dirt, foreign weed seeds, and stones,
   (2) removing hulls or cortex in cracking, aspirating, or screening operations,
   (3) cracking or rough grinding the kernels, meats, or prepressed cake,
   (4) steaming (tempering or cooking) of the meats,
   (5) flaking the small pieces between smooth flaking rolls,
   (6) extracting the oil with solvent,

(7) separating the meal, or marc, from the oil-solvent solution, called miscella, and
(8) removing the solvent from both the miscella and the marc. The marc may be toasted or pelletized, or both, for use in animal feeds.

The amount of ectracted oils varies depending on the amount of prepressing, the type of material being extracted, and the efficiency of the extracting system.

Processing Of Extracted Oil:

The extent of processing applied to fats depends on their source, quality, and ultimate use. Many fats are used for edible purposes after only a single processing step—*i.e.,* clarification by settling or filtering. Most cold-pressed oils (for example, cold-pressed olive, peanut, and some coconut and sunflower oils) can be used in food products without further processing. Tremendous quantities of butter and lard are used without special treatment after churning or rendering. The growing demand for preparation of tasty and stable oils, however, led to extensive processing techniques.

A. Refining

The non-glyceride components contribute practically all the colour and flavour to fats. In addition, such materials as the free fatty acids, waxes, colour bodies, mucilaginous materials, phospholipids, carotenoids, and gossypol (a yellow pigment found only in cottonseed oil) contribute other undesirable properties in fats used for edible and, to some extent, industrial purposes.

- **Alkali refining**

Many of these can be removed by treating fats at 40° to 85° C (104° to 185° F) with an aqueous solution of caustic soda (sodium hydroxide) or soda ash (sodium carbonate).

- **Water refining**

Water refining, usually called degumming, consists of treating the natural oil with a small amount of water, followed by centrifugal separation. The process is applied to many oils that contain phospholipids in significant amounts. Since the separated phospholipids are rather waxy or gummy solids, the term degumming was quite naturally applied to the separation.

B. Bleaching

If further colour removal is desired, the fat may be treated with various bleaching agents. Heated oils are treated with fuller's earth (a natural earthy material that will decolorize oils), activated carbon, or activated clays. Many impurities, including chlorophyll and carotenoid pigments, are adsorbed onto such agents and removed by filtration.

C. Destearinating or winterizing

It is often desirable to remove the traces of waxes (*e.g.,* cuticle wax from seed coats) and the higher-melting glycerides from fats. Waxes can generally be removed by rapid chilling and filtering. Separation of high-melting glycerides, or stearine, usually requires very slow cooling in order to form crystals that are large enough to be removed by filtration or centrifuging. Thus linseed oil may be winterized to remove traces of waxes that otherwise interfere with its use in paints and varnishes.

D. Hydrogenation

For many edible purposes and for some commercial applications it is desirable to produce solid fats. Many shortenings and margarines contain hydrogenated (hardened) oils as their major ingredients. The development of margarine and shortening products resulted from the invention of a successful method for converting low-melting unsaturated fatty acids and glycerides to higher-melting saturated products. The process consists of the addition of hydrogen in the presence of

a catalyst to the double (unsaturated) bonds. Thus oleic or linoleic acid (or their acid radicals in glycerides), which are normally liquid at room temperature, can be converted to stearic acid or the acid radical by the addition of hydrogen.

E. Isomerization reactions

During the catalytic treatment another reaction also takes place—isomerization (rearrangement of the molecular structure) of unsaturated fatty acid radicals to form isooleic, isolinoleic, and similar groups. Because these isomers have higher melting points than do the natural acids, they contribute to the hardening effect. The unsaturation of natural oils has the *cis* configuration, in which hydrogen atoms lie on one side of a plane cutting through the double bond and alkyl groups lie on the other side. During hydrogenation some of the unsaturation is converted to the *trans* configuration, with like groups on opposite sides of the plane. The *trans* isomers are much higher melting than the natural *cis* form.

F. Deodorization

Odourless and tasteless fats first came into high demand as ingredients for the manufacture of margarine, a product designed to duplicate the flavour and texture of butter. Most fats, even after refining, have characteristic flavours and odours, and vegetable fats especially have a relatively strong taste that is foreign to that of butter.

Uses and Health implication of oils and fats

- Oils and fats form an important part of a healthy diet. Structurally they are esters of glycerol with three fatty acids (called either triacylglycerols or triglycerides).
- Bakery products (e.g. pastry and biscuits) require a fat with a moderate amount (25-40%) of solid fat to be present during dough preparation to give a light texture without undue oil exudation in the final product.
- Chocolate needs to be based on cocoa butter from both a legislative and functionality point of view and any fats used to replace cocoa butter need also to conform to legislation and to melt and crystallise in the same way as cocoa butter.
- In general, ice cream needs to be based on a fat which is at least 50% solid at 0°C and which melts below mouth temperature. Frying oils need to have as good an oxidative stability as possible to allow both an extended 'fry life' and also good shelf stability in the end product.
- On top of all this, the oils and fats used should give rise to no adverse health concerns.

Vegetable Fats

Vegetable fats and oils are lipid materials derived from plants. Physically, oils are liquid at room temperature, and fats are solid. Chemically, both fats and oils are composed of triglycerides, as contrasted with waxes which lack glycerine in their structure. Although many different parts of plants may yield oil, in commercial practice, oil is extracted primarily from seeds.

Unsaturated fats

Unsaturated fats are in a liquid form when at room temperature and in the refrigerator, they can be polyunsaturated or monounsaturated. Polyunsaturated fats help your body rid itself of newly formed cholesterol. They keep your blood cholesterol level down and reduce cholesterol deposit build up in your artery walls. Examples of polyunsaturated fats include - fish and fish oil, sunflower oils, corn and soybean. Monounsaturated fat is found in olives, olive and canola oil, most types of nuts and their oils and avocados.

Uses of Fats and Oils:

- Fat is important foodstuff for many forms of life, and fats serve both structural and metabolic functions
- There are many different kinds of fats, but each is a variation on the same chemical structure.
- Fats are also sources of essential fatty acids, an important dietary requirements.

- Fats and oils are categorized according to the number and bonding of the carbon atoms in the aliphatic chain.
- Despite long-standing assertions to the contrary, fatty acids can also be used as a source of fuel for brain cells.
- Organic oils are produced in remarkable diversity by plants, animals, and other organisms through natural metabolic processes.
- Several edible vegetable and animal oils, and also fats, are used for various purposes in cooking and food preparation.
- Fat is one of the three main macro-nutrients: fat, carbohydrate, and protein.
- Fats that are saturated fats have no double bonds between the carbons in the chain.
- Unsaturated fats have one or more double bonded carbons in the chain.

Role of Dietary fats in regulating blood cholesterol level:
The two types of blood cholesterol are low density lipoprotein (LDL) cholesterol and high density lipoprotein(HDL)cholesterol.
LDL is considered the 'bad' cholesterol because it contributes to the narrowing of the arteries, which can lead to cardiovascular diseases (such as heart disease and stroke). HDL cholesterol is considered to be the 'good' cholesterol because it actually carries cholesterol from the blood back to the liver, where it is broken down, reducing the risk of cardiovascular disease.

Benefits of omega-3 fats in human health:
Research is ongoing, but the benefits of omega-3 fats in the diet seem to include that they:
- lower triglyceride levels and reduce blood pressure, which are important risk factors in cardiovascular disease
- improve blood vessel elasticity
- keep the heart rhythm beating normally
- 'thin' the blood, which makes it less sticky and less likely to clot
- reduce inflammation and support the immune system
- may play a role in preventing and treating depression
- contribute to the normal development of the foetal brain.

Benefits of Plant sterols in human health:

Plant sterols are present in all plants. Intakes of 2–3 g of plant sterols per day have been shown to reduce blood cholesterol levels by an average of 10 per cent. This is because they block the body's ability to absorb cholesterol, which leads to a reduced level of cholesterol in theblood.

However, it is hard to eat this amount of plant sterols from natural sources, so there are now plant sterol-enriched margarines and dairy products on the market. Eating 1–1.5 tablespoons (4-6 teaspoons) of sterol-enriched margarine each day can help to lower blood cholesterol levels.

Energy density of dietary fat
Dietary fat has more than double the number of kilojoules per gram (37 kJ/g) than carbohydrate or protein (17 kJ/g), making it very 'energy dense'. Foods high in fat are usually high in kilojoules. Carrying too much body fat is a risk factor in many diseases, including cardiovascular disease, type 2 diabetes and many cancers.

[P.T.O]

Botanical Name, Family and Uses of Mustard, Soybean and Coconut

MUSTARD OIL

Sarson Oil

Brassica campestris Linn.; var. ***sarson*** Prain; Eng. Yellow sarson, Indian colza; Hindi—*Sarson;* Family—Cruciferae (Brassicaceae).

A herb. It is grown as an oil-seed crop mainly in Uttar Pradesh, the Punjab, Bihar and Assam. The oil content is 30 to 45 per cent, and the oil is extracted by expression or solvents.

Uses. The oil is used for cooking and burning purposes. The oil is used as cattle-feed.

SOYBEAN OIL

Soyabean Oil

Glycine max. (L). Merr.; Eng. Soyabean; Hindi—*Bhat, bhatwar, bhetmas, ramkurthi;* Bengali—*Garjkalai;* Assam—*Patnijokra;* Khasi Hills—*Rymbai-Kutung;* Family—Papilionaceae.

The oil, obtained from the seeds, is used in cooking, and is also used in the manufacture of candles, varnishes, soap, paints and insecticides. The oil cake is used as fodder.

A herb. It is native of South-East Asia. In India, it is cultivated mainly in Punjab, Bengal, the Khasia hills, Assam, Manipur, Himachal Pradesh, Kashmir and Bihar.

Uses. The oil obtained from the seeds, is used in cooking. It is also used in the manufacture of candles, varnishes, soap, paints, greases, linoleum, rubber substitutes, cleaning compounds, insecticides and disinfectants. It is also used in making adhesives, plastics, spreaders, foaming solutions and many other products. The oil cake has a good percentage of protein content and is used as cattle feed.

COCONUT OIL

Coconut Oil

Cocos nucifera Linn.; Eng. Coconut; Hindi—*Nariyal;* Family—Palmaceae/Arecaceae.

A tall palm. It is cultivated chiefly in Kerala, Tamil Nadu and Karnataka. The oil obtained from the dried meat of coconut. The oil is pale yellow or colourless and is solid below 74°F. The husks of the nuts are removed and the nuts split open and dried. The copra is then easily removed. This is ground up and the oil is expressed. The oil cake is sometimes put through hydraulic presses a second time, and still more oil is expressed. The yield is about 65 to 70 per cent.

Uses. Refined coconut oil is edible and is extensively used for food products. Unrefined coconut oil is commonly used for cooking in Kerala. This oil is used for making confectionery and candy bars. Coconut oil has long been used for the best soaps, cosmetics shaving creams, shampoos and other toilet preparations. It is the only oil used in marine soaps. It is also used as an illuminant. The oil cake is used as fodder and as manure.