

# OILS AND FATS

## GLOSSARY

**ACIDITY:** Free fatty acids have, as the name implies, a weak acidic nature. There will be a naturally occurring level of these present in each oil and levels can be further increased by hydrolysis (water breakdown) of triglyceride. The level of acidity may be expressed in several ways (please refer to Acid Value and Free Fatty Acids).

**ACID OIL:** Acid oil is a general term for a by-product obtained from the alkali refining of oils and fats. During alkali refining the free fatty acids are neutralised with alkali and this soapstock containing some emulsified neutral oil is separated. Acidification of the soapstock gives acid oil. Main components of acids oils are fatty acids, neutral oil and moisture. Acid oil requires further refining/purification before it is suitable for use in laundry soaps and washing powders.

**ACID PRE-TREATMENT:** The crude oil or fat is pre-treated with phosphoric acid or citric acid to remove impurities such as gums, mucilaginous materials and phosphatides present. Also referred to as "degumming", it is essential since it removes impurities which would otherwise give a highly coloured product.

**ACIDULATE SOAPSTOCK (ACID OIL):** Soapstock, which contains mainly soaps and entrained neutral oil, is treated with sulphuric acid and heated to decompose the soaps. This produces a layer of oil of high free fatty acid content (acid oil) and an aqueous phase which is separated and treated prior to discharge as an effluent. The acid oils can be used in animal feeds as they possess high calorific values.

**ACID VALUE:** This is defined as the number of milligrams of potassium hydroxide required to neutralise the free fatty acids in one gram of fat. Since acid value is an indication of the extent of hydrolysis and deterioration, oils with low acid value are sought after.

**ALKALI REFINING:** The traded quality of oils and fats is determined primarily by the level of free fatty acids present. In crude oils, this may be as low as 0.5% as in soya, or as high as 6.0% as in the case of palm oil. Removal of this impurity is the major source of calculable loss during processing. The term "alkali refining" is applied to the process in which the free fatty acid is reduced chemically by reacting the free acid with an aqueous alkali, forming the alkali metal soap which is then removed by settling or centrifuging.

**AMERICAN OIL CHEMISTS' SOCIETY (AOCS):** One of the largest professional bodies for oils and fats technologists. It has a large international membership and publishes a comprehensive book of analytical methods and two journals - "Lipids" and "Journal of the American Oil Chemists' Society" - with a worldwide circulation. Its headquarters are in Champaign, Illinois, USA.

**AMINO ACIDS:** Chief components of proteins which are the building blocks of living tissues. Eighteen different amino acids commonly occur in our food supply and eight are considered essential because the body cannot make them from other materials.

**ANHYDROUS - FREE OF WATER:** Anhydrous means dry or free from water. Oils are essentially anhydrous after refining and deodorisation, the usual specified maximum moisture level being 0.1%. Butter, made from dairy cream, consists of an emulsion with up to 16% of water. Margarine is formulated likewise. More and more the trend is to lower fat spreads. Anhydrous butter fat (ghee) is made from butter and is commercially available.

**ANISIDINE VALUE:** The anisidine value is a measure of the amount of aldehydes, principally 2-alkenals, present in oils. This gives a qualitative assessment of the amount of secondary oxidation products present in the oil. The anisidine value is determined by reacting a test solution of the oil with p-anisidine, which reacts with the 2-alkenals, and measuring the increase in absorbance at 350 nm, using a spectrometer. The anisidine value is often numerically combined with the peroxide value, a measure of primary oxidation, in the form of the Totox Value (2 x peroxide value + anisidine value) to give an overall assessment of the oxidation which has occurred.

**ANTI-FOAM:** Foam is a two phase system consisting of liquid and gas wherein gas is distributed in the form of small bubbles throughout the liquid. Formation of foam is quite common in some oils and fats during prolonged heating/frying. To overcome or minimise foaming, food additives known as anti-foaming agents, generally silicone based, are added to the oils at very small levels, e.g. 1-5 ppm of Dimethyl Polysiloxane. These additives are usually only incorporated on request from the end user.

**ANTIOXIDANTS:** Substances which inhibit the oxidation of fats and oils. They are added to fats and oils or fat-containing products to provide greater stability and longer shelf-life by delaying the onset of oxidative rancidity.

**BAKING OR FRYING FATS (SHORTENING):** Baking or frying fats are products which meet all of the following conditions -

- a. manufactured from vegetable oils, meat fats or marine oils, singly or in combination;
- b. deodorised or hydrogenated and deodorised;
- c. containing a significant amount of glycerides solid at room temperature, and
- d. produced and sold entirely or primarily for baking or frying purposes.

**BIOTECHNOLOGY:** The use of living organisms or other biological systems to develop food, drugs and other products.

**BLEACHING:** This is a process whereby coloured pigments, impurities, trace metals, gums and oxidised materials are removed from oils and fats by adsorptive cleansing using bleaching clays and/or activated carbons. Bleaching is carried out on highly degummed oils, or acid pre-treated oil in the case of oils of naturally low gum contents, when these are to be physically refined. With alkali refining this stage is incorporated after the alkali refining, prior to deodorisation. Bleaching of edible oils and fats is generally carried out under a vacuum at 70-120°C, with agitation for a pre-determined length of time. The bleaching earth is then removed by filtration.

**BLEACHING EARTH:** Bleaching earths are montmorillonite clays which, in their natural state or after chemical or physical activation, have the capacity to adsorb colouring matters from oils. They are finely-crystalline silicates of aluminium and/or magnesium with variable amounts of lime, alkalis, iron and with a proportion of water of hydration. They are often subjected to various processes, mainly acid and heat treatment to enhance their adsorption capacity. When used with crude oils, they are capable of removing impurities, gums and coloured pigments present.

**BUTTER:** Made by churning cream, often after a refining process. Cream is an emulsion of very small fat droplets in water. Milk proteins and salts are dissolved in the water. During churning, the small fat droplets coalesce until they form a continuous fat phase, in which about 16% of water is dispersed in small droplets. Excess aqueous phase separates off as whey. The emulsion has been changed from a fat-in-water emulsion to a water-in-fat emulsion. It has been "inverted".

**CAROTENE:** A natural constituent which gives crude palm oil its bright orange-red colour and which is normally destroyed by the high temperatures in the refining and/or deodorisation processes. It is also partially destroyed by oxidation under adverse conditions of production, storage and transport of crude palm oil. This may result in a deteriorated crude that is difficult to bleach during refining. Carotene is often added back to manufactured food products to colour them for customer appeal. Physiologically carotene has Vitamin A activity. In view of this, some palm oil processors are now modifying their processors to produce refined, deodorised palm oil products with high residual levels of B-carotene; these still being bright orange/red in colour. Chemically, carotene is a conjugated poly-unsaturated hydrocarbon which, together with related carotenoid compounds, may be estimated using a spectrophotometer to measure light absorbance at the wavelength of 446 nm.

**CATALYST:** A catalyst is a substance which, when added to the components of a chemical reaction, speeds up the rate of that reaction but does not itself become involved chemically. An example of such compounds in the edible oil context is nickel used in hydrogenation.

**CENTRIFUGING:** Substances having different densities will separate by gravity. For example, oil is lighter than water and easily forms a separate upper layer. The effect of gravity can be accentuated by increasing the strength of the gravitational force, for example by spinning at high speed within the inner rotating parts of centrifuge machines. Centrifuging is often used in oil mills for the separation of impurities and water from the oils, in alkali refining to remove soap and water washes and in fractionation, using detergent solutions, to separate wetted fatty crystals from the liquid olein, etc.

**CHEMICAL REFINING:** Refers particularly to the removal of free fatty acids by alkali. The alkali used is usually sodium hydroxide (caustic soda) or sodium carbonate (soda ash), either singly or in combination. One novel chemical refining technique uses aqueous ammonia as the alkali.

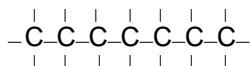
**CHEMISTRY (SIMPLE):** The following nine propositions cover the basic organic chemistry required to understand technical terms used in the oils and fats industry.

- a. The Element Carbon - chemical symbol C - is basic to all chemical substances involved in living things;

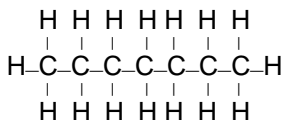
- b. Each atom of Carbon is capable of linking to other atoms by means of four bonds -



- c. Carbon often joins to form linear chains -

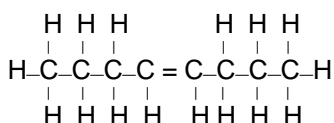


- d. The remaining bonds are often linked to hydrogen -



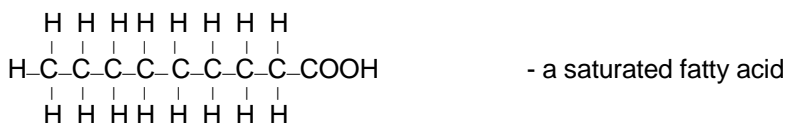
This is a "saturated hydrocarbon" chain as it is not chemically possible to introduce any more hydrogen atoms into the chain.

- e. Sometimes there is a deficit of hydrogens in the hydrocarbon chain.

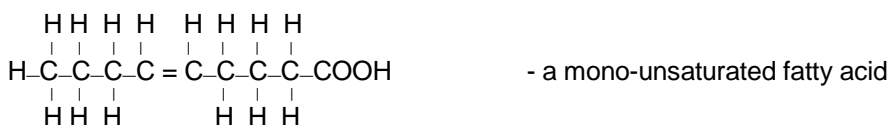


The chain is "unsaturated" i.e. there is one "double bond" between two adjacent carbon atoms. With this structure it is possible to chemically introduce more hydrogen across the double bond in the hydrocarbon chain, reducing the double bond to a single bond, producing a saturated hydrocarbon chain. When one double bond is present, the molecule is said to be "mono-unsaturated". When there is more than one double bond present, the molecule is said to be "poly-unsaturated".

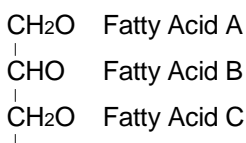
- f. A fatty acid consists of a hydrocarbon chain with an acid group (COOH) at one end.



Or -



- g. Every natural fat, such as palm oil, is a mixture of compounds called triglycerides. Each triglyceride contains three fatty acids joined to one glycerol molecule -



A, B and C may be identical but, normally, they differ from each other in the length of the chain and/or the degree of unsaturation (0-3 or more double bonds may occur).

- h. These differences in A, B and C result in different physical properties in the triglycerides. Some are solid, others are liquid. Each natural fat is a mixture of many triglycerides, say 30-200 or so. Therefore, the physical properties of a fat, such as palm oil, are a sort of average of its major constituents.

- i. The triglycerides make up about 99% of most natural oils. The remaining 1% consists of oil soluble chemicals of different types. Examples are carotenes and tocopherol.

**CHLOROPHYLL:** A natural, green colouring agent vital to a plant's photosynthesis process which is removed from vegetable oils through bleaching and refining processes.

**CHOLESTEROL:** Cholesterol is one of a class of compounds known as sterols. It is an important component in animal tissues and cell membranes but found only in trace amounts in plant tissues. While many vegetable oils are known to contain traces of cholesterol, the amount is much less than in animal fats. Vegetable oils mainly contain other members of the sterol class.

**CHROMATOGRAPHY:** Chromatography is a separation process used to analyse mixtures. The mixture, dissolved in a mobile phase, is contacted with a stationary phase, usually a fine powder. The components of the mixture are adsorbed or retained by the stationary phase to varying extents, depending on the degree of chemical affinity between them. Continual washing of the stationary phase with the original solvent or with a sequence of solvents, washes out the components of the mixture in turn. Various types of chromatography are used. Liquid chromatography involves passing a solution of the mixture through a column of solid adsorbent, or of an inert solid coated with a second immiscible liquid. Gas-liquid chromatography uses a gas as the mobile solvent and is usually carried out at a high temperature so that the components of the mixture are also gaseous. Thin layer chromatography is a form of liquid chromatography in which the solid adsorbent is formed in a thin layer on glass or other flat support.

**CIS:** The term applied to a geometric isomer of an unsaturated fatty acid where the hydrogen atoms attached to the carbon atoms comprising the double bond are on the same side of the carbon chain.

**CLEAR POINT:** The clear point is the temperature at which a fat sample in a closed capillary tube or a U-tube becomes completely clear on warming.

**CLOUD POINT:** The cloud point is the temperature at which the oil begins to cloud resulting from crystallisation under controlled cooling. The cloud point is related to the unsaturation of the oil. In general, the higher the unsaturation of an oil, the lower will be its cloud point.

**COCOA BUTTER:** The seed fat of "Theobroma Cacao", a small tree growing in tropical climates. Normally the cocoa beans are fermented and roasted to develop the desirable cocoa flavour. The beans are then milled to produce cocoa mass. Pressing of the cocoa mass gives cocoa butter. A lower quality of cocoa butter can be obtained by solvent extraction of the solid residues of the press.

**COCOA BUTTER EQUIVALENT:** Fats which behave like cocoa butter in all respects and are able to mix with cocoa butter in any proportion without altering the melting, rheological and processing characteristics of cocoa butter in all types of formulation. These fats have the physico-chemical characteristics of cocoa butter. There is no 100% equivalent available in the market.

**COCOA BUTTER SUBSTITUTE (CBS):** Fats which have a very limited compatibility with cocoa butter as mixing with cocoa butter adversely affects the rheological, melting and processing characteristics of the product. These fats on their own and also with a limited amount of cocoa butter have melting and rheological properties similar to cocoa butter. The degree of compatibility of these fats with cocoa butter and their melting characteristics determine their quality and hence their price. A good quality CBS is hard at ambient temperature, has the sharp melting characteristics of cocoa butter and has some degree of compatibility with cocoa butter and/or cocoa butter-milk fat blends. CBS are mainly used to make imitation products where the fat phase mainly consists of these fats. They are generally based on palm kernel oil or hydrogenated non-lauric fat products. CBS are also sometimes called Cocoa Butter Alternatives (CBA).

**COCONUT OIL:** Coconut oil is the oil obtained from copra - dried coconut meat. An edible oil, coconut oil is distinguished from other edible oils by its high content of short chain saturated acids (predominantly lauric) and its low unsaturated acid content. Susceptible to hydrolysis, coconut oil rapidly develops a characteristic odour and flavour, often described as soapy.

**CODEX ALIMENTARIUS:** A Commission operating under the Food and Agriculture Organisation of the United Nations/World Health Organisation (FAO/WHO) auspices, which has the task of preparing model standards and codes of practice for edible products and for food processes. It operates through a series of Commodity Committees, which have a wide international membership. Nations which have formally acceded to the Commission undertake to adopt Codex standards in their national legislature. The elaboration of each standard is carried out in a series of eleven formal steps involving approval by member governments.

**COLOUR:** Most oil products are preferred as colourless as possible. In the oils and fats trade, the colour of oils is usually measured by the Lovibond Comparator. Alternatively, a spectrophotometer may be used to record the variation of light absorbance over the visible wavelength region of the spectrum.

**COLUMN CHROMATOGRAPHY:** This is a laboratory technique by which two or more substances in a mixture are separated due to their differential affinities for a solid adsorbent. The adsorbent is filled into a column and a solution of the mixture is washed down the column with solvent. Individual components are washed out in sequence according to their molecular size and the type and number of polar functional groups in them. Column chromatography is often used to separate triglycerides on a quantitative basis from the other components in oils and fats. The adsorbent most commonly used is silicic acid (silica gel).

**COMPLEX TRIGLYCERIDE:** A triglyceride where one or two fatty acid structures differ from the third fatty acid.

**CONFECTIONERY FATS:** Fats used for the manufacture of sugar and/or chocolate based confectionery products. These fats generally have sharp melting behaviour, having a very low solid fat content at body temperature. The physico-chemical properties of these fats and hence, their formulation, depend on the particular application and processing involved.

**CONJUGATED FATTY ACIDS:** Polyunsaturated fatty acids exhibiting pairs of unsaturated carbons not separated by at least one saturated carbon.

**COPRA:** The fruit of the tree "Cocos Nucifera" is the well known coconut. The white meat of the coconut, when removed and dried to between 4% to 7% moisture, is called copra. Drying may be either by sun drying where the moisture is allowed to evaporate naturally or forced drying where the heat for drying is obtained by burning the empty shells. This last method causes an uptake of PAH's in the oil making it necessary to bleach with active carbon.

**CORN OIL:** Corn oil is obtained from the germ of the corn (or maize) cob, the germ being separated as a by-product from the manufacture of starch from corn. The corn oil is extracted from the germ and, after refining, it has a number of uses such as frying and as a good quality salad oil. It tends to be darker than refined rapeseed and soyabean oils and it may require dewaxing if it is used for bottling.

**COTTONSEED OIL:** Records show that cotton has been grown for nearly 3,000 years as a source of fibre to be spun and woven into textiles. The seed is a by-product which yields 20-24% of useful food oil.

**CRUDE OIL:** The oil product obtained from the initial extraction, crushing or expelling of an animal or vegetable source.

**CRUDE VEGETABLE OIL:** Extracted vegetable oils which have had no further processing or refining except possibly that of being degummed or filtered, settled or both.

**CRYSTALLISATION:** A substance can exist in three states, namely gaseous, liquid and solid states. When a liquid is cooled sufficiently, it solidifies and the process is called crystallisation. Crystallisation is the formation of crystals from a melt or a solution. The process is used in both the preparation of triglycerides in the small scale and the fractionation of oleins and stearins in the large scale.

**DEGUMMED OIL:** The product resulting from washing crude vegetable oil with water and/or steam for a specified period of time and then centrifuging the oil-and-water mixture to remove the phosphatides etc. The US Bureau of the Census requires crushers degumming crude soyabean oil to report the production of crude oil in terms of degummed weight.

**DEGUMMING:** All fats and oils contain small quantities of various non-glyceride entities. Included in this group are complex organo-phosphorus compounds referred to as phosphatides or more usually as gums. They are removed during processing by a variety of treatments collectively referred to as "degumming". The treatment applied varies but usually involves hydration with water, orthophosphoric acid, polybasic organic acids either singly or in combination, followed by centrifuging the precipitated material or by its adsorption on a bleaching earth or filter.

**DENSITY ("LITRE WEIGHT IN AIR"):** Density is the mass of a unit volume of a substance. The density of an oil or fat is usually measured by determining its specific gravity.

**DEODORISATION:** Deodorisation is the removal of those trace components, present in all edible oils, which give rise to odours and flavours. Accomplished by the application of heat, steam and vacuum, deodorisation should be the final stage of treatment before packing or despatch.

**DETERGENT:** In simple terms a detergent is an aid to separation whether it be the separation of soil from a piece of cloth or the separation of olein from stearin in a fractionation plant. Alternatively classified as surface active agents, they work by lowering surface tension forces between two phases, in so doing allowing the more complete removal of the unwanted entity.

**DETERIORATION:** Chemically, oils and fats are quite stable, neutral substances. However, during storage and transport two types of deterioration can occur -

- a. Oxidation by atmospheric oxygen. This reaction is accelerated by high temperature, strong light and the presence of catalytic trace metals.
- b. Hydrolysis, resulting in splitting of the neutral fat to give free fatty acids. This is accelerated by the presence of water, by high temperature and by microbiological agents such as moulds and yeasts.

Deterioration causes colour and flavour changes (rancidity) which eventually renders an oil unsuitable for food use.

**DIGLYCERIDE:** The ester resulting from the chemical combination of glycerol and two fatty acids.

**DILATION/DILATOMETRY:** When an oil or fat is heated it expands and the expansion is called dilation. Dilation is the change in volume with varying temperature. The technique of observation is termed dilatometry. From the dilation observed on warming a solidified fat to a defined temperature, the solid's content at that temperature can be calculated. Dilatometry has been much used in the oils and fats industry for determining solid fat contents or indices of ingredients and blends in margarine and shortening manufacture. This technique has now been mainly replaced by solid fat content measurement using nuclear magnetic resonance spectrometry.

**DOUBLE BOND:** The configuration of two adjacent carbon atoms with dual linkage between the carbons.

**DROP POINT:** The drop point is an analysis related to the melting point of oils and fats. The sample is solidified in a small cup with a hole. As the cup is warmed and as the fat starts to melt a drop is formed. The drop point is the temperature at which the drop falls freely.

**DRYING OILS:** Oils that have the ability to polymerize or "dry" by oxidation after they have been applied to a surface to form tough, adherent, impervious and abrasive resistant film. Their film forming properties are closely related to their degree of unsaturation. Typical commercial drying oils are linseed oil and tung oil.

**EMULSIFIER:** Agents which markedly lower the interfacial tension between oil and water or other liquid, thus permitting them to mix or form emulsions. Lecithin and mono and diglycerides are emulsifiers derived from fats and oils and are widely used in food products (margarines, shortenings, salad dressing, frozen desserts, peanut butter, candy etc). Emulsifiers may also have other useful properties such as crystal modification and complex formation. The surface activity of these compounds depends on their molecular structure. They are compounds consisting of a non-polar and a polar group. The non-polar group is usually a hydrocarbon chain, such as fatty acids, which has an affinity for oils (lipophilic or hydrophobic), while the polar group is usually a polyol such as glycerol and has affinity for water (hydrophilic or lipophobic). Emulsifiers may be thought of as tadpoles, with the polar head anchored in the water phase, while the long hydrocarbon tail remains dissolved in the oil. The physico-chemical nature of the two groups governs the degree of affinity of the surfactant for oil or water.

**ERUCIC ACID:** Erucic acid consists of a 22 carbon chain with one double bond on the thirteenth carbon atom. It is a major component of seed oils of the brassica family such as rapeseed or mustard seed. High levels of erucic acid in the diet have been found to have undesirable nutritional effects in animal feeding trials. In consequence, plant breeders have developed low and zero erucic acid content rapeseed, which has been commercialised. A high erucic rapeseed oil is used as a mould lubricant in the continuous casting of steel; erucamide, derived from rapeseed oil is an anti-blocking and slip agent in polythene films.

**ESTER:** The chemical reaction product of an alcohol and an acid.

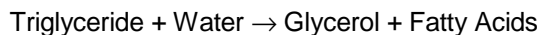
**ESTERIFICATION:** The process of chemically combining an alcohol and an acid resulting in the formation of an ester.

**ESTER VALUE:** The ester value is the number of milligrams of potassium hydroxide required to saponify the neutral oil in one gram of fat. It is equal to the saponification value minus the acid value.

**EXTRACTION (SOLVENT):** The process of obtaining oil from a seed or other source by the use of an organic solvent (usually hexane) is termed extraction. Following several pretreatment steps, culminating in the production of seed flakes, whose oil cell walls have been ruptured under pressure, the oil is extracted by percolation of an organic solvent through a bed of flakes. The solvent is removed from the oil-solvent solution (or miscella) by distillation. This process finds application where the oil content of the material is less than 20%. Where the oil content is much higher, e.g. copra (65%) and palm kernels (50%), most of the oil can be recovered by physical pressure (e.g. screw press) and the oil in the press residue may then be extracted with solvent.

**ESSENTIAL OIL:** A volatile oil obtained as an extract from herbs, spices, flower petals etc and used for its perfume or flavour properties.

**FAT SPLITTING:** Fats and oils are triglycerides which are split on hydrolysis to give glycerol and a mixture of fatty acids. The process is usually carried out with steam at high temperature and pressure (e.g. 260°C and 55 bar).



The process is reversible, hence an excess of water is required to ensure that hydrolysis is the major reaction. The glycerol produced is approximately of 13-15% concentration. This process opens the gateway to the oleochemical field.

**FATS (AND OILS):** Fats and oils are essentially similar in composition and synonymous. They are substances produced by plant and animal life, mainly as an energy store. However, certain components of fats perform essential metabolic functions. Many seeds are rich in fats, palm kernels for example containing about 50%. The fats in seeds are used to nourish the seedling plants in the early stages of growth. Animals lay down fat deposits as a food supply for times of shortage. Such deposits are usually in a layer under the skin. Fat is also laid down by pregnant females and is used up in producing milk for the young. Fat deposits are also laid down specifically surrounding the vital organs, such as the kidney and liver, to act as an insulation and protection. To the chemist, fats are esters of glycerol with fatty acids. Each glycerol molecule combines with three fatty acids, which are usually different. The physical nature of fats is that they are immiscible with water, but dissolve in many organic solvents.

**FATTY ACIDS:** The products obtained when glycerol is split off from the triglycerides of fats and oils by any method of hydrolysis. Triglycerides are composed of three molecules of fatty acids and one molecule of glycerol. Since these acids are found only in natural fats and oils, the term fatty acid applies to any acid that can be obtained from natural fats and oils. After hydrolysis, 100 grams of fat yield approximately 95 grams of fatty acids. In the field of industrial usage, fatty acids are usually further classified according to the treatment to which they are subjected subsequent to hydrolysis. Natural fatty acids are straight hydrocarbon chains with an acidic carboxyl group at one end. They have an even number of carbon atoms, usually between four and twenty-two. The most common chain length however is sixteen and eighteen. They may have one or more double bonds in the chain.

**FATTY ACID DERIVATIVES:** Using fatty acids as starting materials, the oleochemicals industry makes mainly fatty alcohols, esters, amines, amides and soaps as derivatives. These compounds are often reacted further to produce a very wide range of chemicals for consumer or industrial use.

**FATTY ACID FRACTIONATION:** Fatty acids which have been "split" from triglycerides or hydrolysed can effectively be separated according to chain length, by distillation under vacuum, as their volatility varies. This is known as fractional distillation. For example, palmitic acid (C16:0) can be separated from stearic acid (C18:0). Fatty acids can also be fractionated in ways similar to those for edible oils, to separate the more saturated fatty acids from the more unsaturated. For example, a mixture of tallow fatty acids can be fractionated using detergent solution or by low temperature solvent fractionation, to yield commercial stearic acid and commercial oleic acid. The fatty acid fractions are often referred to as "stearine" and "oleine" rather than "stearin" and "olein", these terms being reserved for triglyceride fractions.

**FATTY ALCOHOL:** Fatty alcohol is derived from fatty acids. Two main routes are used to obtain fatty alcohols commercially -

- a. hydrogenolysis of either fats or fatty acids, usually as the methyl ester, and
- b. reduction of fatty esters with an alcohol and alkali metal (as catalyst).

Lauryl and tallow alcohols are commonly used for surfactants.

**FATTY AMINES:** Fatty amines are useful fatty acid derivatives for cationic surfactants. All cationics modify surfaces, especially textile surfaces, which makes them useful as fabric softeners, dye fixatives or water repellents. They are also useful in ore flotation, corrosion inhibition and lubrication.

**FATTY MATTER:** This term is used by the analytical chemist to describe the fatty component of a complex food such as milk, meat, cake or seeds. Fatty matter is usually measured by weight after a suitable extraction procedure.

**FILTRATION:** Filtration refers to the separation of a component from another using a screening material or sieve such as paper, steel mesh or cloth. In the oils and fats industry, filtration is used to remove -

- a. bleaching earth and impurities from the bleached oil in refining;
- b. catalyst from the hydrogenated fat in hydrogenation;
- c. crystals from an oil slurry in fractionation, and
- d. the last trace of solids in a refined oil. This operation is referred to as "polishing" and gives a sparkling clear liquid.

**FIRE POINT:** The temperature at which an oil sample, when heated under prescribed conditions, will ignite for a period of at least five seconds.

**FLAKING:** A process used when extracting oil from seeds. The cooked seeds are usually passed through pairs of rolls which break them down and flatten them to a uniform thickness suitable for efficient solvent extraction.

**FLASH POINT:** Temperature of oil when vapour ignites under test conditions.

**FLASH POINT LIMIT TEST:** ISO 15267 - Method to determine whether a sample of oil or fat at a given temperature will flash when a test flame is applied to the sample under specified conditions.

**FOOTS:** *Visible Footholds* - The insoluble matter in crude fats and oils, together with occluded oil, which settles at 10-20 degrees C above the melting point of the fat or oil. *Sediment* - That part of the insoluble matter in a crude fat or oil which can be centrifugally separated and is the total amount of the unclear layer of components collected at the bottom of the measuring cell after centrifuging. The sediment contains, for example, phospholipids, impurities and dirt, usually dispersed in a water-containing phase. (Note: ISO 15301 - Determination of Sediment in Crude Fats and Oils - Centrifuge Method).

**FRACTIONATION:** Fractionation involves the separation of an oil or fat into two or more fractions. The oil is cooled under controlled conditions and the fractions separated by filtration or centrifugation. Fractionation of a fat is made possible by the solubility differences of the component triglycerides arising from the structural differences of their fatty acids, chain length, degree and type of unsaturation.

**FREE FATTY ACIDS (FFA):** The bound fatty acids in monoglycerides, diglycerides and triglycerides may be broken down into free acids by chemical or enzymatic hydrolysis. Such acids are referred to as "free fatty acids". The amount of free fatty acids in an oil is measured by reacting or titrating the oil with alkali in an alcoholic solution. Crude oils with high free fatty acids result in higher refining losses. Hydrolysis of oils and fats should, therefore, be minimised. While it is the rule to report acidity of fats as oleic acid, the acidity of palm oil and palm kernel oil are usually expressed as palmitic and lauric acids respectively since they predominate in these oils.

**FRESH FRUIT BUNCH (FFB):** The initials stand for "fresh fruit bunch" and refer to the bunch as harvested from the oil palm. Each bunch weighs 10-20 kg and may contain 1500 or more individual fruits. Calculation of oil yield and losses in the oil mill is often referred to the fresh fruit bunch, as this is the material taken in for processing.

**FULLY HYDROGENATED:** The terms describing a fat or oil which has been hydrogenated to the extent that the resultant product is solid at room temperature. Products containing hydrogenated fats include heavy duty frying fats for restaurant use, solid shortenings and solid margarines.

**FULLY REFINED OIL:** The term used to describe an oil which has been subjected to extensive processing methods to remove - (1) free fatty acids and other gross impurities (refine); (2) naturally occurring colour bodies such as chlorophyll (bleach), and (3) volatile trace components which may affect colour, flavour and odour (deodorise).



**GEOMETRIC ISOMER:** An isomer differing because of the structural location of certain elements.

**GHEE:** "Ghee" is a word derived from the Hindi word "Chi" meaning clarified and crystallised butter fat from buffalos or cows milk. Ghee made from buffalos milk is white, whereas that made from cows milk is yellow in colour. These products have a rich and pleasant flavour and have a granular structure. Granularity is considered by the consumers in some tropical countries as an important criterion of quality and purity of these products.

**GLYCERIDES (TRIACYLGLYCEROLS):** Natural fats and oils are mixtures of triglycerides. The esters of fatty acids combined with glycerol are often referred to as "triglyceride". Typical fatty acid compositions are tabled in Appendix B. In general solid fats contain a relatively high proportion of the saturated fatty acids and oils contain higher proportions of unsaturated or shorter chain fatty acids.

**GLYCEROL OR GLYCERINE:** Glycerol is an important structural component of fats and oils. A complete splitting (hydrolysis) of fats/oils results in glycerol and free fatty acids. Glycerol finds uses as a humectant, a food ingredient, in pharmaceutical products and in explosives. Glycerol can be synthesised from petroleum feedstock.

**GOSSYPOL:** A natural constituent of cotton seeds which, if transferred to the crude oil, results in colour instability and an oil which is difficult to process. The cooking procedure of the cotton seeds is critical in determining whether gossypol is bound in the meal or transferred to the oil.

**GRANULARITY:** Agglomeration of crystals resulting in the formation of granules generally visible to the naked eye. There are a number of fat-based products, such as vanaspati and ghee, where a granular structure is very much appreciated by the consumers and is considered as a quality parameter. A granular texture in fat-based products is not only determined by the chemical composition of the fat/fat blends, but also by the way the product is cooled from the melt. Generally, large granules are obtained by slow cooling of the product. Rapid cooling results in smaller crystals and smooth texture.

**GROUNDNUT OIL OR PEANUT OIL:** The oil expressed or extracted from the seed of the groundnut ("Arachis Hypogaea") after removing the husk and the germ. Groundnuts are extensively cultivated in China, India, USA and in a number of African countries, for example Senegal, Nigeria and Sudan. The plant is unusual in pushing its unripe seed into the ground, where ripening takes place. Groundnut oil is a highly prized cooking oil.

**HARD BUTTER:** A generic term used primarily in the confectionery industry to describe a class of fats with physical characteristics similar to those of cocoa butter or dairy butter.

**HEAT BLEACHING:** The process by which the natural carotene which colours crude palm oil is destroyed in the final stage of refining during deodorisation at temperatures above 240°C. Sometimes called "thermal bleaching".

**HEAVY METALS:** Refers to metals such as copper and iron. Their presence in oils and fats is undesirable due to their pro-oxidant effect.

**HYDROGENATION:** Each double bond in an unsaturated fatty acid chain can react with two hydrogen atoms to become saturated. The chemical reaction is known as hydrogenation and is achieved by reacting the oil with gaseous hydrogen at elevated temperature and pressure in the presence of a catalyst. Hydrogenation of oils and fats is often referred to as "hardening".

**HYDROLYSIS:** Oils and fats consisting predominantly of triglycerides can be split into compounds of lower molecular weight such as fatty acids, monoglycerides, diglycerides and glycerol. The splitting process is termed "hydrolysis". It is caused by chemicals such as water, acids and alkalis (chemical hydrolysis) or by enzymes (enzymatic hydrolysis). Enzymatic hydrolysis of fats is a normal part of the digestive process. The splitting of esters is termed hydrolysis because a molecule of water is added on at each ester bond.

**IMPURITIES:** This refers to insoluble extraneous matter found in oils and fats. It may consist of dirt and miscellaneous debris, mineral matter, nitrogenous materials of animal or vegetable origin and carbohydrate substances such as vegetable fibres. Impurities are determined by weighing the dry residue obtained after they are separated from the sample which has been dissolved in a specific solvent, usually petroleum ether.

**INERT GAS BLANKETING:** Inert gas, usually nitrogen, put in the ullage space in a pressurised tank to prevent air oxidation of the product.

**INFRARED RADIATION:** The visible light is only a small fraction of the electromagnetic waves. Waves with wavelength longer than the visible red are generally called infrared radiation. Infrared radiation is that section of the spectrum covering the range from the limit of the visible spectrum to the shortest microwave. Both infrared and ultraviolet spectra are useful in the analysis and identification of fats.

**INTERCHANGEABILITY:** All fats have a common basic chemical structure, being triglycerides. However, because the fatty acids in combination vary, the physical properties of different fats are not identical. In general, liquid character is imparted by unsaturated acids and by short chain length saturated acids. Solid character is imparted by long chain saturated acids or by unsaturated acids in the transconfiguration. Since liquid oils can be changed by hydrogenation into solid fats, a substantial degree of interchangeability exists between the different products. This interchangeability is however limited. For example, it is not practicable to turn saturated (solid) acids in unsaturated (liquid). Also, the short chain saturated acids impart certain desirable qualities which cannot be obtained otherwise. Nonetheless, interchangeability is an important factor in determining the market price relationship between various oils.

**INTERESTERIFICATION:** Interesterification modifies the natural distribution of the fatty acids in fats and oils. By the use of a catalyst the combined fatty acids are induced to become detached from their original glycerol molecule and reattached in a random manner (random interesterification). A modification of this process is to lower the temperature until some of the newly formed high melting glycerides crystallise out (directed interesterification). The processes result in a different triglyceride composition which, in turn, leads to physical properties different from the native fats or oils. The products may be more useful for making margarine, vanaspati and shortening.

**IODINE VALUE:** Iodine value is a measure of the total number of unsaturated double bonds present in an oil. Determination of iodine value involves the addition of an excess of halogen to the sample, reaction of the excess halogen with potassium iodide and titration of liberated iodine with standard sodium thiosulphate using starch solution as the indicator. Of the many procedures available, the most widely used are the Wijs (iodine monochloride) and Hanus (iodine) methods.

**IRON:** Iron acts as a catalyst in oxidation processes and thus it is detrimental to the quality of oils and fats. Iron is a trace metal, its presence in vegetable oils is mainly due to contamination such as wear and tear of machinery during extraction and during transportation. The natural iron content of a crude oil can rise to 4 or 5 ppm due to milling processes, transport and storage. The normal iron content of fully refined oil is 0.1 ppm or less. However, contamination during transport occasionally causes substantial increases.

**ISOMER:** Compounds containing the same elements in the same proportions which can exist in more than one structural form, e.g. geometric, positional or cyclic.

**KARL FISCHER:** The measurement of small amounts of water in oils and fats is most suitably done by the Karl Fischer procedure in which the water is reacted with a special reagent. Unlike methods using oven drying, the Karl Fischer method is specific for water. It is particularly suitable for water contents below 0.2% in oil.

**LARD:** The rendered fat of the pig. One of the traditional cooking fats, especially in Europe and USA. The best quality lard is obtained from the internal fats surrounding the kidney etc. Pork backfat is significantly softer in character.

**LAURIC ACID:** Lauric acid is a commonly distributed, naturally occurring saturated fatty acid (C12:0). The richest common sources of lauric acid are coconut, palm kernel and babassu oils.

**LAURIC OILS:** Oils containing 40-50% lauric acids (C12) in combination with other relatively low molecular weight fatty acids. Coconut and palm kernel oils are principal examples.

**LECITHIN:** The mixed phosphatides obtained from vegetable oils in the degumming process. The main source is from soybean oil.

**LINOLEIC ACID:** Linoleic acid is the most important poly-unsaturated fatty acid, naturally occurring in natural fats and oils (C18:2). It is an essential fatty acid, i.e. a dietary requirement for healthy animals. Physiologically important as a precursor for the production of prostaglandin.

**LINOLENIC ACID:** It is widely distributed in nature as a major component of many of the more highly unsaturated vegetable oils (C18:3). It is a major component of linseed oil and its high degree of unsaturation is responsible for the drying properties of the oil.

**LIPID:** Historically a general term for natural organic products that are insoluble in water but soluble in organic solvents. The most common lipids are the neutral triglycerides (oils, fats) but the term includes minor components, often of biological importance, such as phosphatides, sterols, squalene and partial glycerides.

**LIPOPROTEIN:** Any of the class of proteins that contain a lipid combined with a simple protein.

**LOVIBOND:** This refers to a widely used system by which the colour of an oil can be measured. The essential features of this system consist of a light source, a series of calibrated coloured glasses forming the standards of reference and an instrument in which they can be matched against the oil. The colour scale consists of three series of coloured glasses - red, yellow and blue. These glasses are moved into position against the sample viewed until a match is obtained. This removal method is now becoming obsolete since a fully automated Lovibond meter was developed. The method was first developed by Mr Lovibond for the measurement of the colour of beer at his brewery in Salisbury, England in the Eighteenth Century and has been traditionally used for oil colours.

**MARGARINE:** Margarines are semi-solid or consistent fatty foods originally developed to imitate dairy butter. They therefore contain a proportion of emulsified aqueous phase similar to that found in butter. The amount of moisture permitted in margarine is limited by law to a maximum of 16% in most countries while the fat content is required to be at least 80%. The aqueous phase may contain dissolved salt and an amount of milk solids treated to impart a butter-like flavour. Permitted colour is often added to give a butter-like pale yellow. Vitamins A and D are also often added. While the original purpose in developing margarine over 100 years ago was to supplement inadequate supplies of butter, there has been considerable diversifications of margarine products, particularly in the last 30 years. The following main types can be listed -

- a. table margarines in packets;
- b. table margarines in tubs;
- c. tub margarine with a high content of poly-unsaturated oils;
- d. domestic cooking margarines;
- e. industrial margarines for general purposes, and
- f. industrial margarines for puff pastry.

Nowadays, the trend is to reduce the fat content to produce spreads or "halvarines".

**MARINE OIL:** The first common source of marine oil was obtained from whales. Today, whale numbers have been reduced to insignificance. Various types of fish are caught for processing into meal and oil, for example, herring, menhaden and anchovy. After refining and partial hydrogenation fish oils, are useful ingredients for margarines and shortenings. World production is close to one million tonnes.

**MEDIUM-CHAIN TRIGLYCERIDE (MCT):** Triglycerides containing fatty acid chains of 6-10 carbon atoms which are readily absorbed by the body.

**MELTING:** When heated sufficiently, a solid changes state to a liquid. The melting of a fat depends on its previous triglyceride composition. The baking or spreading performance of commercial fats depends greatly on their melting behaviour. Solid fat content measurement is commonly used to monitor this behaviour.

**METHYL ESTERS:** The fatty acid composition of an oil is normally determined by using Gas Liquid Chromatography of the fatty acid methyl esters (FAME analysis). The methyl ester derivatives of fatty acids are comparatively volatile. Methyl esters of fatty acids are conveniently prepared by displacing the glycerol from the triglycerides of the oil, using methanol in the presence of an alkaline or acidic catalyst.

**MOISTURE:** Since water is only very slightly soluble in fats, it is present only in small amounts and is referred to as moisture. Moisture in oils and fats may be determined by drying, distillation, absorption or titrimetry. The presence of water, especially when in large amounts, may enhance hydrolysis especially at elevated temperatures.

**MONOGLYCERIDE (MONOACYLGLYCEROL):** Monoglyceride is a compound used as an emulsifier in margarine/peanut butter etc, to help the uniform dispersion of oil in water. Monoglycerides do not occur naturally in appreciable quantities except in fats and oils that have undergone partial hydrolysis. For instance, fats and oils that are damaged or spoiled in the field or in storage and have abnormally high free fatty acid contents will have corresponding high di- or monoglyceride content.

**MONOUNSATURATED:** A fatty acid containing only one pair of carbon-carbon double bonds.

**MYRISTIC ACID:** Myristic acid (C14:0) is a saturated intermediate chain length fatty acid found mainly in coconut, palm kernel and milk fats. It is also a minor constituent of most animal and vegetable fats.

**NATURAL ANTIOXIDANT:** An antioxidant which is naturally present in fat, e.g. tocopherols and tocotrienols. Their presence confers good keeping properties on the fat. Most vegetable oils have a relatively high content of tocopherol and tocotrienols.

**NEUTRALISATION:** The reduction of free fatty acids in a crude oil by the action of an alkali solution is ordinarily termed "neutralisation".

**NEUTRAL OIL:** When a crude oil has been neutralised with an alkali, the residual material, i.e. crude oil less FFA, phosphatides, moisture and impurities, is then neutral oil.

**NONCONJUGATED FATTY ACIDS:** Polyunsaturated fatty acids exhibiting pairs of carbons separated by at least one saturated carbon atom.

**NUCLEAR MAGNETIC RESONANCE:** The phenomenon of nuclear magnetic resonance (NMR) occurs when an appropriate radio frequency field is applied to a sample containing dipolar nuclei (e.g. protons in fat) placed in a strong d.c. magnetic field. Low resolution NMR spectrometry is used to measure the solid fat content of fat samples and the oil content of seeds. The NMR spectra of triglycerides exhibit characteristic peaks each, produced by protons of different character and, for structural analyses, high resolution NMR spectrometers are required.

**OIL CONTENT:** The term refers to the amount of fatty material present in materials of animal and vegetable sources and food products, etc. To measure the oil content of a material it is usually necessary to prepare the sample by drying, grinding or digestion. The oil is then thoroughly extracted with solvent. The extract is filtered, the solvent removed and the oil is weighed.

**OILS (AND FATS):** Oils and fats are synonymous. However, the difference between them is that the former are liquid at ambient temperatures, while the latter are solid in appearance. Since ambient temperatures vary so much, a rigorous definition is not possible but, conventionally, a temperature of 20°C is often used as reference. Generally, the oils contain a higher proportion of unsaturated fatty acids in their composition than the fats.

**OILSEED HULLS:** The outer covering of oilseeds.

**OILSEED MEALS:** The product obtained by grinding the cake, chips or flakes which remain after removal of most of the oil from oilseeds. Oilseed meals are mainly a feedstuff for livestock and poultry. Some meals are also used as a raw material for producing edible vegetable protein products.

**OILSEED PROCESSING:** The procedure involved in removing oil from oilseeds. There are three basic types of processes - solvent extraction, mechanical processing and hydraulic pressing.

**OLEATE:** An ester or salt of oleic acid. Commonly referenced as a preparation containing oleic acid as the principal ingredient.

**OLEIC ACID:** It is the most widely distributed of all the fatty acids, found in practically every vegetable and animal fat. Rich sources are olive and peanut oils. Oleic acid contains 18 carbon atoms and one double bond, in the cis-configuration.

**OLEIN/PALM OLEIN:** This is the liquid, more unsaturated fraction separated from palm oil after crystallisation at a controlled temperature. The olein contains the lower melting point, more liquid triglycerides allowing it to be used for some applications for which the parent oil may not be suitable.

**OLEAN (OLESTRA):** A sucrose fatty acid polyester used as a substitute for dietary fat which is not digested or absorbed by the body.

**OLIVE OIL:** Olive oil is obtained from the flesh of the fruit of the olive tree ("*Olea Europaea Sativa*"). The cultivation of olives in the countries of the Mediterranean basin goes back several thousand years and it remains today a highly prized edible oil used in the unrefined state. It has a strong characteristic flavour and a yellow green colour. Olive oil and palm oil are the only fruit flesh oils in international trade. All other vegetable oils are seed oils.

**ORGANOLEPTIC TEST:** Refers to the careful tasting and odour assessment procedures carried out by experienced personnel. An important test on all fully refined oils which should be bland in odour and taste. Both the senses are involved in organoleptic testing when freshly produced.

**OXIDATION:** Process in which the unsaturated fatty acids of oils and fats react with oxygen, resulting in rancidity. Oils and fats in contact with oxygen present in the atmosphere will cause chemical changes in the product which will downgrade the quality. Oxidation proceeds more rapidly as the temperature increases, so advisable to carry out each operation at the lowest practicable temperature. The rate of oxidation is greatly increased by the catalytic action of copper or copper alloys, even when trace amounts are present. Copper and copper alloys must be excluded from the transportation systems. Other metals, such as iron, also have catalytic effects, although less than those of copper. Oxidation is reduced by limiting air contact.

**OXIDISED OIL:** Deteriorated oil due to attack by atmospheric oxygen which has occurred either during processing or during subsequent storage and transport. The chemical change is gradual and progressive but the effect on quality can be very great. Commonly assayed by peroxide value for primary oxidation and anisidine value for secondary products, both types of oxidation can also be measured directly in an ultra-violet spectrophotometer.

**POLYCYCLIC AROMATIC HYDROCARBON (PAH):** PAH's occur mainly, and to high levels, in coconut oil because of the practice of smoke drying the copra. However, PAH's have also been detected in other oils, although at a much lower level. Removal of PAH's is by proper deodorisation in combination with treatment of active carbon.

**PALM ACID OIL:** It is a by-product obtained from the alkali refining of palm oil resulting from the acidulation of soapstock. It is normally used for making laundry soaps.

**PALM FATTY ACID DISTILLATE (PFAD):** It is a term used specifically for the by-product obtained from palm oil refined by steam distillation (physical refining). PFAD contains free fatty acid (major component) and a small amount of unsaponifiable material and neutral oil, including mono and diglycerides. PFAD has been used to partially substitute some beef tallows in the production of laundry soap.

**PALMITIC ACID:** Palmitic acid, having a 16 carbon atom chain, is the most widely distributed saturated fatty acid. It occurs in practically all animal, vegetable and marine animal fats and is a major component of lard, tallow, palm oil and cocoa butter.

**PALM KERNEL CAKE:** The residue after pressing and/or solvent extraction of palm kernels to obtain the oil. Used as a component of animal feed.

**PALM KERNEL OIL:** The oil obtained from the kernel of the oil palm fruit. Its chemical composition is quite different from that of the palm oil obtained from the flesh. Palm kernel oil is a lauric type oil similar to coconut oil.

**PALM MID FRACTION:** Palm mid fraction (PMF) is obtained by a two stage fractionation. Usually, in the first stage, the highest melting solid components are removed and, in the second stage, the most liquid. The solid residue of the second stage has sharp melting properties that make it highly suitable for use in confectionery products.

**PALM OIL:** The oil obtained from the fruit flesh of the oil palm (*Elaeis Guineensis*). World production in 1995/96 was estimated by the USDA at 15.69 million tonnes, Malaysia and Indonesia being the major producing countries. Most of the plantings today are of the "tenera" variety obtained by crossing dura (thick shell) and pisifera (almost shell-less). The fruit characteristics of tenera are almost ideal.

**PARTIALLY HYDROGENATED:** The term used to describe an oil which has been lightly to moderately hydrogenated to shift the melting point to a higher temperature range and increase the stability of the oil. Partially hydrogenated oils remain liquid and are used in a wide variety of food applications.

**PARTS PER MILLION (PPM):** The expression is used to describe the concentration of trace constituents, whether those deliberately added such as antioxidants, or contaminants such as iron and copper.

**PASSIVATION:** A nitric acid wash of high chromium stainless steel ship's tanks to form a very thin oxide film on the metal surface which serves as a protective barrier.

**PEROXIDE VALUE:** Fats consist of saturated and unsaturated acids. The unsaturated acids are susceptible to oxidation, that is oxygen, can add to the fatty chain to form peroxides or hydroperoxides. The peroxide value is a measure of the amount of these products. It is usually expressed as the milli-equivalents of peroxide-oxygen combined per kilogram of fat. The determination of peroxides is based primarily on their ability to liberate iodine from potassium iodide in glacial acetic acid followed by titration of the liberated iodine with sodium thiosulphate using starch as indicator.

**PHOSPHATIDES:** These are lipids which contain combined phosphoric acid in their chemical composition. Phosphatides (or phospholipids) are important structural and functional constituents of the membranes of biological tissue and are also the major constituent of the gums of unprocessed oils and fats. The residual phosphatides in the crude oil have to be removed by pretreatment (degumming and/or neutralisation) and earth adsorption in the first stages of refining.

**PHOSPHORUS:** Phosphorus is a chemical element which has an important functional role in the phospholipid molecule. During the refining of oils and fats, it is important to remove the phosphorus before high temperature treatment in the deodoriser. Therefore, analysis of phosphorus provides useful information to the technologist. The analysis is usually carried out by a colour reaction after charring and ashing the oil sample or, alternatively, in an atomic absorption spectrophotometer. To convert phosphorus to phospholipids, a multiplication factor of 25 to 30 is used.

**PHYSICAL REFINING:** In simple terms, physical refining may be defined as free fatty acid removal by the action of high temperature, high vacuum and with live steam applied directly to the oil. Physical refining, also frequently referred to as "steam refining", may more accurately be described as distillative deacidification. This process normally precedes deodorisation within the same unit.

**PIGGING:** At any bulking installation loading, unloading and other pumping lines are used interchangeably for different types of oils or different products of the same oil. The oil left behind in any pipeline after the pumping operation could be as much as 5-10 tonnes, depending upon the length and diameter of pipeline. In order to recover the oil fully and to avoid contamination with other oils, the cleaning operation of the internal surface of the pipeline known as "pigging" is carried out. This is done by blowing "pigs" through pipelines by compressed air or nitrogen.

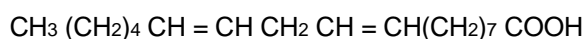
**PIGS:** "Pigs" are used for cleaning pipelines. Hard pigs consist of several, usually three, discs of plastic on a central shaft. They are a close fit in the pipeline to be cleaned. They are pushed through by gas or air and evacuate any product ahead of them in the pipeline. They can also be fitted with wear compensating wire brushes when a more thorough pipe cleaning operation is required. Soft pigs consist of cylindrical plugs of foamed plastic, pushed through the pipeline in the same way.

**PLASTICISE:** The process of creating a solid crystal structure in a fat or oil product resulting in a smooth appearance and firm consistency.

**POLYMERISE;** The bonding of similar molecules into long chains or branched structures.

**POLYMORPHISM:** The property of fat molecules to exist in multiple crystalline structures; identified as alpha, beta and beta prime.

**POLY-UNSATURATED FATTY ACIDS (PUFA):** Fatty acids having two or more double bonds in their carbon chain. The most common poly-unsaturated fatty acid is linoleic acid.



Corn oil, sunflowerseed and soyabean oil are rich in poly-unsaturates. Poly-unsaturated fatty acids are recognised as more healthy than saturated fatty acids.

**POSITIONAL ISOMER:** An isomer differing in the location of a double bond.

**PROTEIN:** A naturally occurring combination of amino acids, containing the chemical elements carbon, hydrogen, oxygen, nitrogen and sometimes sulphur. One of the essential constituents of all living things and of the diet of animals and man.

**QUALITY ASSESSMENT:** Often termed "Quality Control" or "QC", it is the measurement of chemical or physical properties to establish whether a sample conforms to specification. In manufacturing, such laboratory analyses are carried out periodically and the results are used to optimise the process. In trade, it is the basis of specifications in the contract between buyer and seller.

**QUALITY DETERIORATION:** See under Deterioration.

**RANCIDITY:** Rancidity is the development of off-odours and off-flavour in edible oils and fats or manufactured food products caused by oxidative deterioration. Primary oxidation products are odourless and tasteless but certain secondary decomposition products have particularly potent off-flavours and are detected by the palate at extremely low concentrations.

**RAPSEED OIL:** The oil obtained from the seeds of "Brassica Napus" and "Brassica Campestris". In common with other brassica oils such as mustard oils, rapeseed has a high content of erucic acid. Since this was found to have some adverse nutritional effects in animal feeding trials, breeding research has succeeded in producing low erucic or zero erucic acid oils. In addition, rapeseed oil contains sulphur containing chemicals which cause difficulty in processing. These have also been removed by breeding. The importance of rapeseed oil is that the crop can be grown in northerly climates such as Sweden, Germany, Poland and Canada, where other oilseeds crops do not succeed.

**REFINED, BLEACHED AND DEODORISED OIL (RBD):** The initial letters of the words Refined, Bleached and Deodorised are used as a quality description of a fully processed oil. In Malaysia, RBD is used for a physically refined oil. After transport, RBD oils have to be re-refined before using them in the final food product.

**REFINING:** All crude oils and fats contain unwanted impurities. These impurities consist essentially of free fatty acids, gums, trace metals, odoriferous material and water. The various processes involved to remove all of these entities are normally referred to collectively as "refining".

**REFINING FACTOR:** The refining factor is used to monitor product losses in the refinery. It is defined as the ratio of percent loss to percent FFA, corrected for moisture and impurities. A refining factor can be calculated for one or more processing stages.

**REFINING LOSS:** The loss from the original quantity of crude oil resulting from various refining processes. This loss varies considerably depending on the free acid content of the oil, other substances removed during refining and the method of refining.

**REFRACTIVE INDEX:** The velocity of light changes as it travels from one medium to another and the light is then said to have undergone refraction. In effect, the rays of light are bent at the interface between the two media. The refractive index of a substance is the ratio of the velocity of light in a vacuum to the velocity of light in the substance. For practical measurement, air is used as the reference rather than vacuum. For oils and liquid fats, AOCs Method Cc 7-25 is used to measure the refractive index.

**RELATIVE DENSITY:** See Specific Gravity.

**RENDERING:** The process of separating animal fat from tissue and cellular structure by the application of heat, pressure, solvent or a combination of these.

**SAPONIFICATION VALUE:** The saponification value is defined as the number of milligrams of potassium hydroxide required to saponify completely one gram of the substance. It is a measure of the free and combined fatty acids present. By deducting the acid value from the saponification value, we obtain the ester value representing only the combined fatty acids in the neutral oil. The mean molecular weight of the fat can be calculated from the saponification value. The amount of glycerine in the neutral oil can be calculated from the ester value. The saponification value is measured by saponifying a known weight of an oil or fat with an excess of an alcoholic solution of potassium hydroxide followed by titration of the remaining alcoholic alkali with standard acid.

**SATURATED ACIDS:** Important components of fats and oils. The most common saturated fatty acids are palmitic, stearic, lauric and myristic.

**SESAME OIL:** The oil obtained from the seeds of "Sesamum Indicum" and "Sesamum Orientale". An edible oil grown and prized in some Middle East countries, in India and in Central America. Sesame oil gives a characteristic colour reaction and is a required addition to vanaspati in India, to enable the detection of mixtures of vanaspati with ghee.

**SHORTENING:** Anhydrous fats used in the bakery industry, catering trade and also in domestic kitchens. Plasticity is imparted to these products by texturisation of the feed stock (generally blends of two or more oils and fats) in scraped surface tube coolers to produce small crystals enmeshing liquid oil in a crystalline network. In some cases, gas is also incorporated to improve their plasticity. Animal fats, being solid fats, were the first materials used for making shortenings. Compound shortenings using liquid oil and oleo-stearin from animal fats replaced 100% animal fat-based shortening.

Hydrogenation of oils enabled the manufacturer to replace animal fat with hydrogenated oil and develop shortenings based on 100% vegetable oils/fats. Shortenings are formulated and produced to satisfy specific markets and users requirements and therefore show a wide variation in physical properties. The following types of shortenings can be listed -

- a. bakery shortenings (e.g. plastic shortenings, high ratio cake shortenings and liquid shortenings).
- b. industrial shortenings for the catering trade, and
- c. domestic shortenings.

**SIMPLE TRIGLYCERIDE:** A triglyceride comprised of three identical fatty acids.

**SLIP POINT:** Fats consist of a complex mixture of glycerides and therefore do not have sharp melting points, unlike pure chemical substances. The slip point of a fat is the temperature at which a column of fat in an open capillary tube moves up the tube when it is subjected to controlled heating in a waterbath. Because of their polymorphic behaviour, the slip point of some fats is dependent on the previous temperature treatment, i.e. tempering of the sample and, therefore, not very reliable analysis.

**SMOKE POINT:** The temperature at which smoke is visibly evolved from an oil as it is being heated. The smoke point is highly dependent on the content of free fatty acids in the oil. A high smoke point is desirable, particularly when using an oil for frying.

**SOAP:** Soap is commonly used to describe the chemical compound formed by the reaction of an alkali or a metal with fat or fatty acids. Sodium soaps are the most usual products used for toilet and laundry washing. Calcium, potassium and ammonium salts have some specialised uses.

**SOAP STOCK:** The aqueous by-product from the chemical refining operation that is comprised of soap, hydrated gums, water, oil and other impurities.

**SOLID FAT CONTENT:** Fats such as butter, margarine, bakery shortening, beef tallow and cocoa butter appear to be solid but are, in fact, a mixture of solid and liquid components. The proportion of solid present at various temperatures of use is often of interest in relation to the function to be performed, for example, the spreading of butter on bread. A simple and rapid measurement of the solid fat content (SFC) can be obtained by the use of a nuclear magnetic resonance (NMR) instrument. The measurement depends on the fact that the protons of the combined hydrogen atoms of fat in the liquid state are more mobile than those of the fat in the solid state. The mobile protons are therefore more responsive to a magnetic field and this fact can be used to measure the proportion of liquid fat present. The method is superseding the dilation procedure.

**SOLVENT:** This refers to a medium in which other substances can be dissolved. Typical solvents for oils and fats are hexane, petroleum spirit, acetone and ether. Organic solvents are used industrially to extract oils and fats from plant seeds and to separate desirable fractions from oils and fats in fractionation.

**SOLVENT EXTRACTION:** A process which usually uses hexane as a solvent to extract oil from oil-bearing materials. The residual oil left in extracted soyabean flakes or meal can be reduced to one percent or less. In the United States, nearly all soyabeans are processed by solvent extraction. A substantial part of cottonseed, flaxseed and other oilseeds is handled by this method.

**SOYABEAN OIL:** Soyabean oil is obtained by solvent extraction of the soyabean. The oil content of the bean is about 18%, but the residue is a valuable high protein feed meal and represents about 60% of the sale value of the crop.

**SPECIFIC GRAVITY:** The specific gravity of a substance is the ratio of the mass of a given volume of the substance to the mass of an equal volume of water at a specific temperature. In the AOCS Methods Cc 10a-25 for oils and liquid fats (Cc 10b-25 for solid fats), the ratio is measured at 25°C.

**STEARIC ACID:** Chemically, an 18 carbon chain saturated acid. Commercially, the term is used for mixed solid acids of various compositions. Stearic acid is used for industrial purposes such as in the rubber and oleochemical industries. Beef tallow is the principal source of commercial stearic acid. Stearic acid is one of the most important saturated fatty acids present in the triglycerides of both animal and vegetable fats/oils. Stearic acid and its derivatives have uses in many industries, such as the pharmaceutical and cosmetic industries.



**STEARIN:** The term refers to the solid fraction of an oil obtained by filtration or centrifugation after the oil has been crystallised at a controlled temperature. Stearins are characterised by being more saturated than the oils from which they are derived. Fractionation of palm oil yields palm stearin which is used in shortenings, vanaspati, margarines and soap.

**STERILISATION:** Sterilisation is the first process carried out at the oil mill. Fresh fruit bunches are loaded into cages as soon as possible after arrival at the mill, and the cages, which run on rails, are loaded into a horizontal cylindrical pressure vessel. The load is cooked under steam pressure for about 1½ hours. By this means, enzymes are inactivated and the fruit is softened.

**STEROL:** A compound made up of the sterol nucleus and 8-10 carbon side chain and an alcohol group.

**STRIPPING:** Stripping is the process of removing free fatty acids by steam distillation during physical refining. This is usually carried out in the deodoriser. This is the second operation of the palm oil mill. After sterilisation each cage is tipped into a hopper which feeds a rotating drum in which the fruit is knocked out of the bunch. Empty bunches are rejected as waste.

**SUNFLOWER OIL:** Sunflower oil is obtained from the decorticated seeds of the sunflower ("Helianthus Annuus"). A high quality unrefined edible oil may be obtained by cold pressing of the seeds but the bulk of the commercial product is obtained by hot pressing and solvent extraction followed by refining. Sunflower is grown extensively in the southern parts of Eastern Europe, principally the USSR, but has recently also been produced in the USA and, more important, in Western Europe (France).

**TALL OIL:** A by-product of the sulphite digestion of wood pulp for kraft paper manufacture. Tall oil is not a true fat or oil but consists of a natural mixture of 45 percent each of rosin acids and fatty acids and 10 percent unsaponifiable matter. The fatty acids are primarily oleic, linoleic, and linolenic acid.

**TALLOW:** The rendered fat obtained mainly from beef carcass trimmings from the slaughter house. Some sheep fat may be included in commercial tallow, particularly in Australia and New Zealand. Tallow may be of edible or inedible quality. The latter is derived from lower quality raw materials. Inedible tallow is sold in a number of quality grades and is widely used in soap manufacture and as a source of fatty acids for the oleochemicals industry.

**TASTE:** A subjective quality characteristic. It is not defined unambiguously and is evaluated differently by different people. It is mostly defined as the sense by which certain properties are perceived through the stimulation of the taste buds (the gustatory sense) when the food is chewed and comes in contact with the various areas of the tongue. The four basic tastes are salty, sweet, sour and bitter.

**TITRATION:** The strength of a chemical solution is often determined by reacting the chemical with another in measured amounts. Knowing the chemical reaction involved and the amount of the second reactant, the amount of the first reactant can be calculated. The process of reacting and matching the two solutions is called titration. One example is the determination of free fatty acid content by titration with an alkali.

**TITRE TEST:** The titre is the highest temperature reached during the crystallisation of fatty acids under controlled cooling conditions. It is an important characteristic of inedible fats used for soap making or as a raw material for acid manufacture and it is also an indication of the firmness of natural fats.

**TOCOPHEROL:** A natural antioxidant found in vegetable oils and fats. There are four naturally occurring tocopherol homologs, i.e.  $\alpha$ -,  $\beta$ -,  $\gamma$ - and  $\delta$ - tocopherols. In addition, there are four analogous tocotrienols with the same chemical structures, but having three double bonds in the side chain. Palm oil contains both  $\alpha$  tocopherol and tocotrienols. Tocopherols are also known as Vitamin E - the most active is  $\alpha$ - tocopherol.

**TOTOX VALUE:** Index of the degree of oxidation in which the peroxide value and anisidine value are combined -

$$\text{Totox} = 2\text{PV} + \text{AV}$$

**TRACE METALS:** Refers to metals which are present in very small amounts. Copper and iron are trace metals found in vegetable oils. The level decreases in refining and increases if there is contamination.

**TRANS:** A geometric isomer of an unsaturated fatty acid where hydrocarbons attached to the carbons comprising the double bond are on opposite sides of the carbon chain.

**TRANS FATTY ACIDS (TFA):** Trans fatty acids are naturally present in animal fats and are formed during the partial hydrogenation of oils. They are unsaturated fatty acids in which the hydrogen atoms attached to the carbon atoms in the double bond are on opposite sides of the double bond, whereas these hydrogen atoms are on the same side of the double bond in "cis" unsaturated fatty acids. The trans fatty acids have a relatively straight hydrocarbon chain, whereas "cis" fatty acids are bent at the point of the double bond. The difference in structures allows closer packing of molecules of trans fatty acids and triglyceride molecules which contain them. Consequently, the trans fatty acids and their triglycerides have higher melting points than the corresponding "cis" fatty acids and their triglycerides.

**TRIGLYCERIDES (TRIACYLGLYCEROL):** See Glyceride.

**ULLAGE:** The difference between the total volume of a tank and the volume of the material it is presently holding.

**ULTRAVIOLET RADIATION:** The visible light is only a small fraction of the spectrum of electromagnetic waves. Waves with wavelength shorter than the visible violet are generally called "ultraviolet radiation". Ultraviolet radiation is the electromagnetic wave in the range between the visible spectrum and x-rays. Both ultraviolet and infrared spectra are useful in the study of oils and fats.

**UNSAPONIFIABLE MATTER:** The term refers to material present in oils and fats which, after saponification of the oil or fat by alkali, is extractable by solvent and remains nonvolatile on drying. Unsaponifiable matter generally constitutes less than 1% in most oils and fats. It consists of hydrocarbons, higher alcohols, sterols and tocopherols.

**UNSATURATED FATTY ACIDS:** Fatty acids containing one or more double bonds. Oleic, linoleic and linolenic acids are the most common naturally occurring unsaturated fatty acids in animal and vegetable fats and oils.

**VANASPATI:** The term "vanaspati" originated in Indo-Pakistan sub-continent. In sanskrit "Vanas" means forest and "Pati", lord. Hence, literally vanaspati means Lord of the Forest, thus a tree, plant or a vegetable. This emphasises the vegetable origin of vanaspati, as opposed to animal origin of its most familiar counterpart, Ghee, used in Indo-Pakistan sub-continent as an all-purpose cooking medium. In these countries, vanaspati is by legal definition produced from hydrogenated vegetable oils. In India and Pakistan the formulation, production and marketing of vanaspati are controlled by law.

**VOLATILE MATTER:** Volatile matter is the material in oils and fats which volatilises upon drying of the oil or fat at 105°C. It includes moisture, solvent and any low molecular weight compounds present. Volatile matter is determined by drying a weighed quantity of the oil or fat in an oven at 105°C. The loss in weight calculated as a percentage of the weight of oil used constitutes the volatile matter. A high content of volatile matter will accelerate the process of hydrolysis in oils and fats. A maximum level of volatile matter in vegetable oils is usually specified in contracts.

**WAXES:** Waxes are esters of fatty acids combined with long-chain alcohols. The fatty acids are usually straight-chain, saturated or monounsaturated compounds containing up to thirty carbon atoms. The alcohols are usually saturated, long-chain primary alcohols. Wax esters are found in animal and insect secretions as protective coatings in leaves and fruits and in the fats of some marine animals.

**WINTERISATION:** Some crude edible oils, especially those obtained by solvent extraction, contain among their non-oil components traces of wax from the seed coat which tend to give the oil a cloudy appearance. In addition, some liquid oils have a small content of high melting glycerides. These components may be removed by slow chilling of the oil followed by filtration. This process is called "winterisation". After being subjected to winterisation, the oils should be able to pass the standard AOCS Cold Test.

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