##  Sengamala Thayaar Educational Trust Women’s College

## (Affiliated to Bharathidasan University)

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**FOOD CHEMISTRY**

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**FOOD CHEMISTRY**

**Chemical**[**Properties of fat**](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=9109)

* + The most important chemical reaction of neutral fat is their hydrolysis to yield
	+ three molecules Alkali hydrolysis (saponification)The process of alkali hydrolysis is called 'saponification'
	+ The alkali salt of fatty acid resulting from saponification is soap.
	+ The soaps we use for washing consists of Na or K salts of fatty acids like palmitic, stearic and oleic acid.
	+ The potassium soaps are soft and soluble whereas the sodium soaps are hard and less soluble in water.
	+ Enzyme hydrolysis
	+ Hydrolysis of triacylglycerol may be accomplished enzymatically through the action of [lipases](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=9327).
	+ [Lipases](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=9327) are widespread in both plants and animals.

 **Rancidity**

* + Development of disagreeable odour and taste in fat or oil upon storage is called rancidity.
	+ Rancidity reactions may be due to hydrolysis of ester bonds (hydrolytic rancidity) or due to oxidation of unsaturated fatty acids (oxidative rancidity).

 **Hydrolytic rancidity**

* + This involves partial hydrolysis of the triacylglycerol to mono and diacylglycerol.
	+ The hydrolysis is hastened by the presence of moisture, warmth and [lipases](http://ecoursesonline.iasri.res.in/mod/page/view.php?id=9327) present in fats or air.
	+ In fats like which contains a high percentage of volatile fatty acids,hydrolytic rancidity produces disagreeable odour and taste due to the liberation of the volatile butyric acid.
	+ Butter becomes rancid more easily in summer.

 **Oxidative rancidity**

* + The unsaturated fatty acids are oxidised at the double bonds to form peroxides, which then decompose to form aldehydes and acids of objectionable odour and taste.

 **Hydrogenation**

* + The degree of unsaturation of the fatty acids present in triacylglycerol determines whether a fat is liquid or solid at room temperature.
	+ The presence of more unsaturated fatty acids lower the melting point.
	+ The presence of highly unsaturated fatty acids makes the oil more susceptible to oxidative deterioration.
	+ The objective of hydrogenation is to reduce the degree of unsaturation and to increase the melting point of the oil.
	+ The oil can be selectively hydrogenated by careful choice of catalyst and temperature.
	+ Hydrogenation of unsaturated fats in the presence of a catalyst is known as hardening.
	+ Normally the process of hydrogenation is partial so as to get desired characteristics and to avoid products with high melting points.
	+ Hydrogenation is carried out in a closed container in the presence of finely powdered catalyst (0.05 - 0.2% of nickel) at temperature as high as 180oC.
	+ The catalyst is usually removed by filtration.
	+ During hydrogenation process a proportion of the cis double bonds are isomerized to trans double bonds and there is also migration of double bonds.
	+ The hydrogenation process has made it possible to extend the food uses of a number of vegetable oils and marine oils whose melting points are too low.

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[**Physical properties of oils and fats**](https://www.btsa.com/en/physical-properties-of-oils-and-fats/)

The analysis of the physical properties of oils and fats allows us to understand the behavior and characteristics of these elements, as well as their differences. For this, the crystallization, the melting point, the viscosity, the refractive index, the density, the solubility, the plasticity and the emulsifying capacity will be analyzed.
Here we provide more detail on each of these.

**Crystallization**

Fats differ from oils in their degree of solidification at room temperature, since in these conditions the oils are in a liquid state (not crystallized) while the fats are in the solid (crystallized) state.

The proportion of crystals in fats have great importance in determining the physical properties of a product. Fats are considered solid when they have at least 10% of their crystallized components.

The fat crystals have a size between 0.1 and 0.5 μm and can occasionally reach up to 100 μm. The crystals are maintained by Van der Waalls forces forming a three-dimensional network that provides rigidity to the product.

An important feature of fat is its crystalline polymorphism since mono-di and triglyceride crystallize in different crystalline forms (α, β, β’)

* **Form α (vitreous state):**
	+ appears when the fat solidifies by a quick method.
	+ the crystals formed are of the hexagonal type and are organized randomly in space.
* **Form β:**
	+ it occurs when the cooling is slow or if the tempering is carried out at a temperature slightly below the melting point, this form being the most stable of all.
	+ in the β form, tricyclic crystals are formed oriented in the same direction.
	+ the β form is typical of palm oil, peanut, corn, coconut, sunflower, olive and lard.
* **Form β’:**
	+ it is produced from the tempering above the melting point of the α form.
	+ in the β-form, orthorhombic crystals are formed which are oriented in opposite directions.
	+ the β’form is typical of modified partial cottonseed oil, fats, fats and modified lard.

Both α, β and β’form have a melting point, an X-ray diffusion pattern and a refractive index.
The more double bond there is, the crystallization with which it tends to be liquid is hindered.

**Melting point**

The melting point of a fat corresponds to the melting point of the β form which is the most stable polymorphic form and is the temperature at which all the solids melt.

When short chain or unsaturated acids are present, the melting point is reduced.

The melting point is of great importance in the processing of animal fats.

The melting points of pure fats are very precise, but since fats or oils are made up of a mixture of lipids with different melting points we have to refer to the melting zone which is defined as the melting point of the fat component. the fat that melts at a higher temperature.

**Viscosity**

The viscosity of a fat is due to the internal friction between the lipids that constitute it. It is generally high due to the high number of molecules that make up a fat.

By increasing the degree of unsaturation the viscosity decreases and when the length of the chain increases the fatty acids components also increases the viscosity.

**Refractive index**

The refractive index of a substance is defined as the ratio between the speed of light in air and in matter (oil or fat) that is analyzed.

Increasing the degree of unsaturation increases the refractive index and when the length of the chain increases, the refractive index also increases and that is why it is used to control the hydrogenation process.

As the temperature increases, the refractive index decreases.

The refractive index is characteristic of each oil and fat, which helps us to perform a quality control on them.

**Density**
This physical property is of great importance when it comes to designing equipment to process grease.

Density decreases when fats dilate when going from solid to liquid

When the fats melt, their volume increases and therefore the density decreases.

For the control of percentages of solid and liquid in commercial fat, dilatometric curves are used.

**Solubility**

Solubility has great relevance in the processing of fats.

Fats are fully soluble apolar solvents (benzene, hexane …).

Except for phospholipids, they are completely insoluble in polar solvents (water, acetonitrile). They are partially soluble in solvents of intermediate polarity (alcohol, acetone)

The solubility of fats in organic solvents decreases with increasing chain length and degree of saturation.

Phospholipids can interact with water because the phosphoric acid and the alcohols that compose them have hydrophilic groups.

Generally the surface tension increases with the length of the chain and decreases with temperature. Surface tension and interfacial tension decrease with ease with the use of surfactant agents such as monoglycerides and phospholipids.

 **Plasticity**

It is the property that has a body to preserve its shape by resisting a certain pressure.

The plasticity of a fat is caused by the presence of a three-dimensional network of crystals inside which liquid fat is immobilized.

For a grease to be plastic and extensible there must be a ratio between the solid and liquid part (20 -40% solid state fat), the nets must not be tight and their crystals must be in α form.

The plastic fats act as a solid until the deforming forces that are applied break the crystal lattice and the grease passes to behave like a viscous liquid and therefore can be smeared.

**Emulsifying capacity**

The emulsifying capacity is the capacity in the water / oil interface allowing the formation of emulsio

# PROPERTIES OF EGG PROTEIN

Not to be confused with albumen (egg white), albumins are a class of water-soluble proteins found in egg white as well as milk and blood serum. All substances that contain albumins are known as albuminoids. Although an egg white is composed primarily of water, [about 10%](http://www.aeb.org/food-manufacturers/eggs-product-overview/egg-products-specifications/45-egg-white-types) of the clear and viscous substance contains proteins like albumins, globulins, and mucoproteins. Egg albumin protein is a valuable ingredient in many food products, including pet food and pet treats, due to its nutritional benefits and its ability to thermally coagulate and bind ingredients together.

#### Egg Albumin Protein

Unlike yolk, egg white contains very little fat and no cholesterol, making it an important ingredient in the food formulation industry. It accounts for over half the weight of the egg, and it is an excellent source of protein. A simple form of protein, egg albumin protein presents several unique characteristics that make it extremely useful to pet food manufacturers.

First, as we mentioned previously, it offers thermal coagulation. Upon first cracking an egg, you can observe the translucency and soft, liquid-like nature of the egg white. When cooked, the heat causes denaturation, hardening the albumen and coloring it opaque white. The changes in viscosity and color reflect the denaturation of the egg albumin protein.

Next, albumin is water-soluble. This characteristic assists with the incorporation and dispersion of the protein when making pet foods or treats. When a protein offers high solubility, its range of potential applications may expand. Egg albumin protein is also soluble in dilute saline solutions.

#### Types of Albumins Within Egg White

There are many different proteins in the family of albumins. Each of these functional proteins has a specific purpose, from aiding in the digestive process and binding cells to boosting the immune system. They assist food product developers as they work to overcome formulation challenges. Within egg white, you will find these two predominant proteins:

* **Ovalbumin:** The primary protein in egg white, ovalbumin provides nourishment and binds digestive enzymes. It makes up approximately 54% of the protein in egg albumen ([source](https://academic.oup.com/ps/article/92/12/3292/1584028/Egg-white-proteins-and-their-potential-use-in-food)).
* **Ovotransferrin:** Ovotransferrin, a glycoprotein, is the most heat-labile protein within egg albumen (meaning it is the first protein to start gelling when albumen is exposed to heat). Previously known as conalbumin, it makes up approximately 12% of the protein in egg albumen.

Other proteins within the egg albumen include ovomucoid, ovomucin, globulin, and lysozyme. And in addition to protein, the egg white contains nutrients like magnesium, riboflavin, potassium, sodium, and niacin and minerals like zinc, phosphorous, copper, and calcium.

One of the great benefits of egg albumin is that, unlike many other foods, it loses little nutritional value when cooked. Consider adding IsoNova’s innovative dry egg products like OvaBind™ (Patent No. 8,916,156), Ova 70, or OvaTrition™ to your pet food or pet treats to take advantage of the albumins within egg white.

**Volatile compounds**

**Volatile organic compounds** (**VOCs**) are [organic chemicals](https://en.wikipedia.org/wiki/Organic_compound) that have a high [vapor pressure](https://en.wikipedia.org/wiki/Vapour_pressure) at ordinary [room temperature](https://en.wikipedia.org/wiki/Room_temperature). Their high vapor pressure results from a low [boiling point](https://en.wikipedia.org/wiki/Boiling_point), which causes large numbers of molecules to [evaporate](https://en.wikipedia.org/wiki/Evaporation) or [sublimate](https://en.wikipedia.org/wiki/Sublimation_%28phase_transition%29) from the liquid or solid form of the compound and enter the surrounding air, a trait known as [volatility](https://en.wikipedia.org/wiki/Volatility_%28chemistry%29). For example, [formaldehyde](https://en.wikipedia.org/wiki/Formaldehyde), which evaporates from [paint](https://en.wikipedia.org/wiki/Paint) and releases from materials like [resin](https://en.wikipedia.org/wiki/Resin), has a boiling point of only –19 °C (–2 °F).

VOCs are numerous, varied, and ubiquitous. They include both human-made and naturally occurring chemical compounds. Most [scents or odors](https://en.wikipedia.org/wiki/Odour) are of VOCs. VOCs play an important role in communication between plants,[[1]](https://en.wikipedia.org/wiki/Volatile_organic_compound#cite_note-1) and messages from plants to animals. Some VOCs are dangerous to human health or cause harm to the [environment](https://en.wikipedia.org/wiki/Natural_environment). [Anthropogenic](https://en.wikipedia.org/wiki/Human_impact_on_the_environment) VOCs are regulated by law, especially indoors, where concentrations are the highest. Harmful VOCs typically are not acutely [toxic](https://en.wikipedia.org/wiki/Toxic), but have compounding long-term health effects. Because the concentrations are usually low and the symptoms slow to develop, research into VOCs and their effects is difficult.

## Biologically generated VOCs

Not counting [methane](https://en.wikipedia.org/wiki/Methane), biological sources emit an estimated 1150 [teragrams](https://en.wikipedia.org/wiki/Orders_of_magnitude_%28mass%29#106_to_1011_kg) of [carbon](https://en.wikipedia.org/wiki/Carbon) per year in the form of VOCs.[[19]](https://en.wikipedia.org/wiki/Volatile_organic_compound#cite_note-unexplored-19) The majority of VOCs are produced by plants, the main compound being [isoprene](https://en.wikipedia.org/wiki/Isoprene). The remainder are produced by animals and microbes. Microbial volatile organic compounds (mVOCs) can also be beneficial, when used to control plant pathogens, for instance[[20]](https://en.wikipedia.org/wiki/Volatile_organic_compound#cite_note-20).

The strong odor emitted by many plants consists of [green leaf volatiles](https://en.wikipedia.org/wiki/Green_leaf_volatiles), a subset of VOCs. Emissions are affected by a variety of factors, such as temperature, which determines rates of volatilization and growth, and sunlight, which determines rates of [biosynthesis](https://en.wikipedia.org/wiki/Biosynthesis). Emission occurs almost exclusively from the leaves, the [stomata](https://en.wikipedia.org/wiki/Stomata) in particular. A major class of VOCs is [terpenes](https://en.wikipedia.org/wiki/Terpene), such as [myrcene](https://en.wikipedia.org/wiki/Myrcene).[[21]](https://en.wikipedia.org/wiki/Volatile_organic_compound#cite_note-21) Providing a sense of scale, a forest 62,000 km2 in area (the US state of Pennsylvania) is estimated to emit 3,400,000 kilograms of terpenes on a typical August day during the growing season.[[22]](https://en.wikipedia.org/wiki/Volatile_organic_compound#cite_note-22) VOCs should be a factor in choosing which trees to plant in urban areas.[[23]](https://en.wikipedia.org/wiki/Volatile_organic_compound#cite_note-23) Induction of genes producing volatile organic compounds, and subsequent increase in volatile terpenes has been achieved in maize using (Z)-3-Hexen-1-ol and other plant hormones.[[24]](https://en.wikipedia.org/wiki/Volatile_organic_compound#cite_note-24)

volatile compounds important in the flavor of raw vegetables and their various ''processed" forms. The majority of volatile compounds identified in garlic, like those of onions, contain one or more atoms of sulfur, and these compounds dominate the flavor of this vegetable, either raw or processed. The chapter discusses the formation of volatile compounds during the cooking of asparagus, and investigates several model systems to provide support for the proposed synthetic pathways. The volatile components were found to be produced mainly in the young leaves. The buds and less often the leaves, ''sprout tops," of the Brussels sprouts plant are eaten cooked with the main meal. The fresh leaves of parsley are widely used whole as a garnish, but when chopped, either fresh or dried, they add a strong characteristic flavor to many foods.