DEPARTMENT OF NUTRITION AND DIETETICS

FOOD CHEMISTRY

I B.SC NUTRITION AND DIETETICS

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CHEMISTRY OF FATS AND OILS

- SYNOPSIS
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  - Structure of fats and oils
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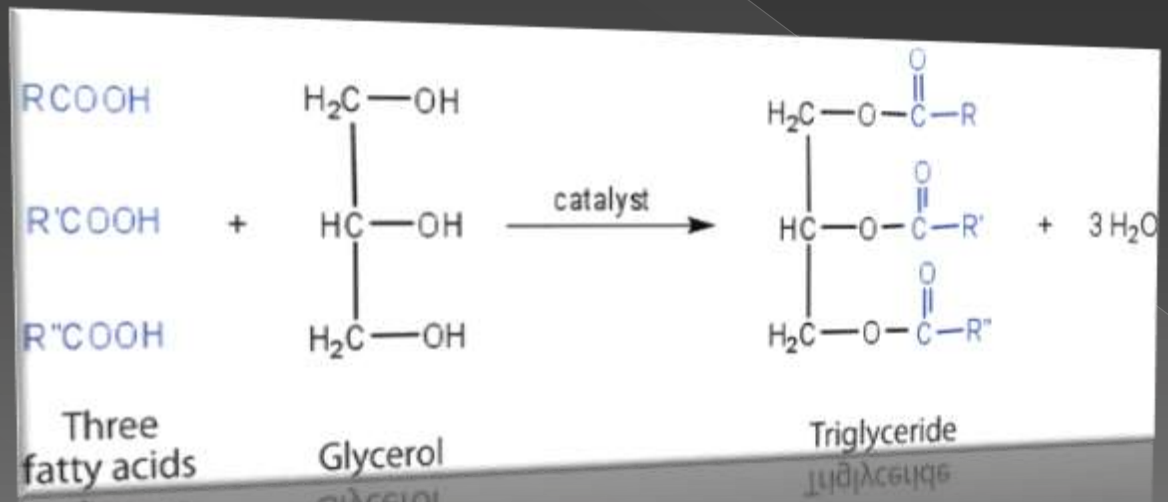
INTRODUCTION

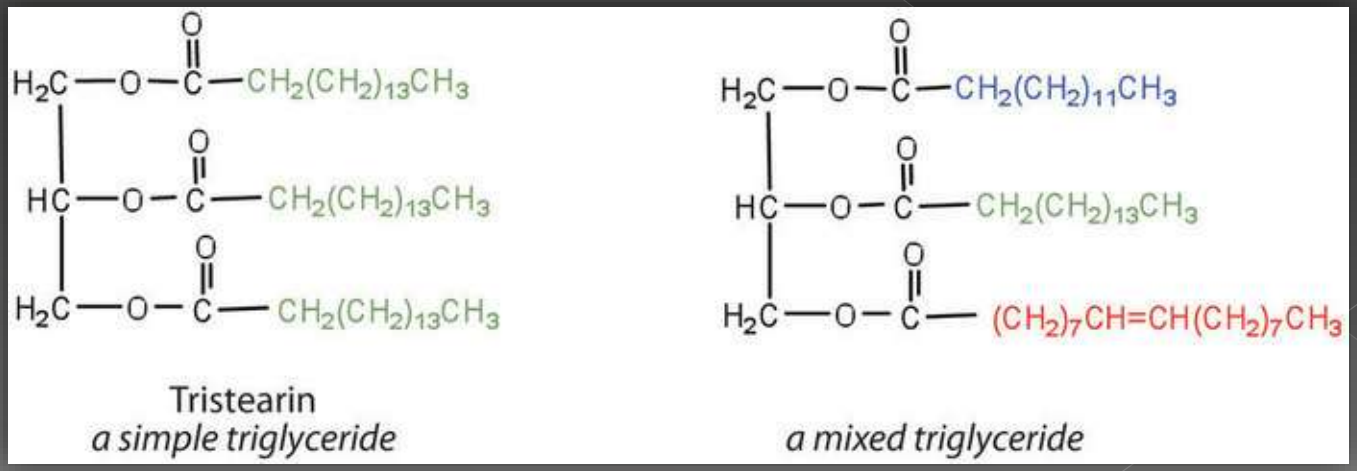
Fats and oils are the most abundant lipids in nature. They provide energy for living organisms, insulate body organs, and transport fat-soluble vitamins through the blood.

STRUCTURE OF FATS AND OILS

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



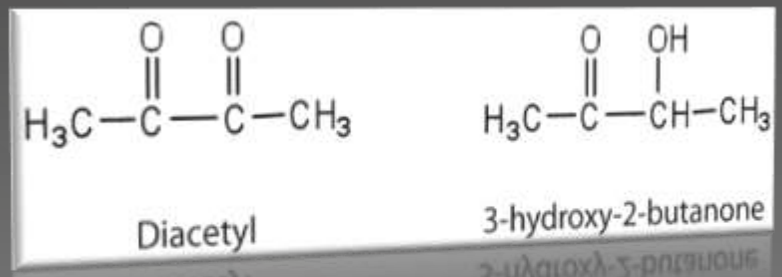
- If all three OH groups on the glycerol molecule are esterified with the same fatty acid, the resulting ester is called a *simple triglyceride*.
- Although simple triglycerides have been synthesized in the laboratory, they rarely occur in nature.
- Instead, a typical triglyceride obtained from naturally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



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

PHYSICAL PROPERTIES OF FATS AND OILS

- Contrary to what you might expect, *pure* fats and oils are colorless, odorless, and tasteless.
- The characteristic colors, odors, and flavors that we associate with some of them are imparted by foreign substances that are lipid soluble and have been absorbed by these lipids.

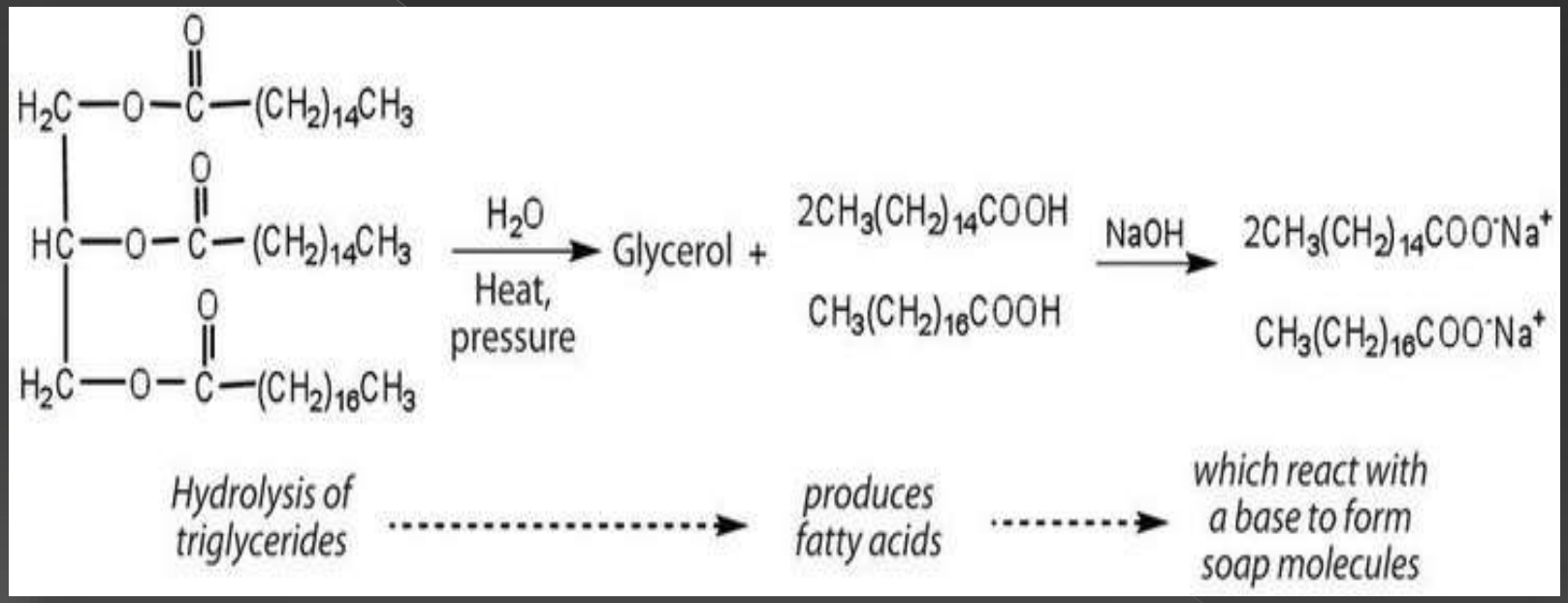


- For example, the yellow color of butter is due to the presence of the pigment carotene; the taste of butter comes from two compounds—diacetyl and 3-hydroxy-2-butanone—produced by bacteria in the ripening cream from which the butter is made.
- Fats and oils are lighter than water, having densities of about 0.8 g/cm^3.
- They are poor conductors of heat and electricity and therefore serve as excellent insulators for the body, slowing the loss of heat through the skin.

CHEMICAL PROPERTIES OF FATS AND OILS

- Fats and oils can participate in a variety of chemical reactions—for example, because triglycerides are esters, they can be hydrolyzed in the presence of an acid, a base, or specific enzymes known as lipases.
- The hydrolysis of fats and oils in the presence of a base is used to make soap and is called saponification.
- Today most soaps are prepared through the hydrolysis of triglycerides (often from tallow, coconut oil, or both) using water under high pressure and temperature [700 lb/in^2 (~50 atm or 5,000 kPa) and 200°C]. Sodium carbonate or sodium hydroxide is then used to convert the fatty acids to their sodium salts (soap molecules):

SAPONIFICATION

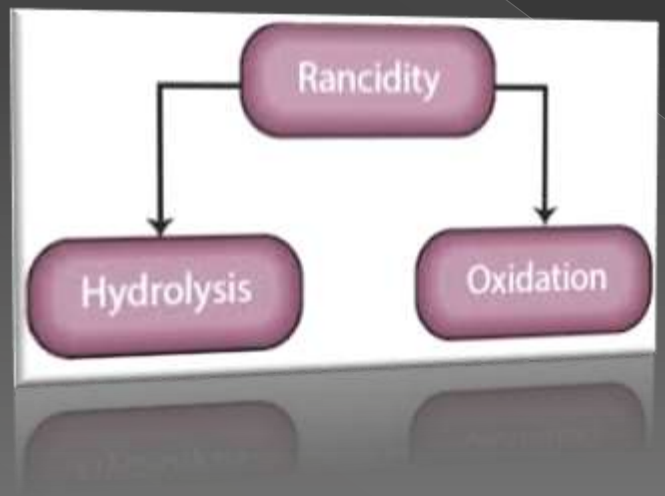


RANCIDITY

- Rancidity is a major concern of the food industry, which is why food chemists are always seeking new and better antioxidants, substances added in very small amounts (0.001%–0.01%) to prevent oxidation and thus suppress rancidity.
- Antioxidants are compounds whose affinity for oxygen is greater than that of the lipids in the food; thus they function by preferentially depleting the supply of oxygen absorbed into the product.
- Because vitamin E has antioxidant properties, it helps reduce damage to lipids in the body, particularly to unsaturated fatty acids found in cell membrane lipids.

TYPES OF RANCIDITY

- Oxidative Rancidity
- Hydrolytic Rancidity

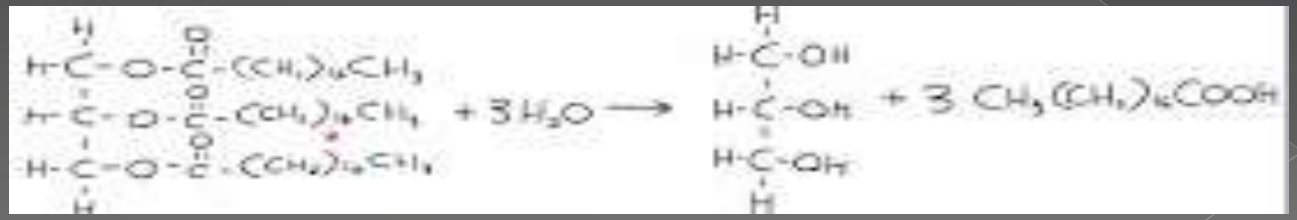


OXIDATIVE RANCIDITY

- **Oxidative rancidity** in foods refers to the perception of objectionable flavours and odours caused by **oxidation** of the unsaturated fatty acid chains of lipids by atmospheric oxygen.
- Because of the 'spontaneous' nature of the reaction the process is frequently referred to as autoxidation.

HYDROLYTIC RANCIDITY

Hydrolytic rancidity refers to the odor that develops when triglycerides are hydrolyzed and free fatty acids are released. This reaction of lipid with water may require a catalyst, leading to the formation of free fatty acids and glycerol.



CONCLUSION

- Fats and oils are composed of molecules known as triglycerides, which are esters composed of three fatty acid units linked to glycerol.
- An increase in the percentage of shorter-chain fatty acids and/or unsaturated fatty acids lowers the melting point of a fat or oil.
- The hydrolysis of fats and oils in the presence of a base makes soap and is known as saponification. Double bonds present in unsaturated triglycerides can be hydrogenated to convert oils (liquid) into margarine (solid).
- The oxidation of fatty acids can form compounds with disagreeable odors. This oxidation can be minimized by the addition of antioxidants.