Vegetable oils

Vegetable oils are obtained from plants. They are important ingredients in many foods, and can be hardened through a chemical process to make, for example, margarine. They can also be used as fuels, for example as biodiesel. Emulsifiers are food additives that prevent oil and water mixtures in food from separating.

Vegetable oils are natural oils found in seeds, nuts and some fruit. These oils can be extracted. The plant material is crushed and pressed to squeeze the oil out. Olive oil is obtained this way. Sometimes the oil is more difficult to extract and has to be dissolved in a solvent. Once the oil is dissolved, the solvent is removed by distillation, and impurities such as water are also removed, to leave pure vegetable oil. Sunflower oil is obtained in this way.

**Structure of vegetable oils**

Molecules of vegetable oils consist of glycerol and fatty acids. In the diagram below you can see how three long chains of carbon atoms are attached to a glycerol molecule to make one molecule of vegetable oil.

![Diagram of a vegetable oil molecule](image)
You do not need to know any details about the structure of vegetable oil molecules for the exam.

Vegetable oils have higher boiling points than water. This means that foods can be cooked or fried at higher temperatures than they can be cooked or boiled in water. Food cooked in vegetable oils:

- cook faster than if they were boiled
- have different flavours than if they were boiled.

However, vegetable oils are a source of energy in the diet. Food cooked in vegetable oils releases more energy when it is eaten than food cooked in water. This can have an impact on our health. For example, people who eat a lot of fried food may become overweight.

**Saturated and unsaturated fats and oils**

The fatty acids in some vegetable oils are saturated: they only have single bonds between their carbon atoms. Saturated oils tend to be solid at room temperature, and are sometimes called vegetable fats instead of vegetable oils. Lard is an example of a saturated oil.

The fatty acids in some vegetable oils are unsaturated: they have double bonds between some of their carbon atoms. Unsaturated oils tend to be liquid at room temperature, and are useful for frying food. They can be divided into two categories:

- **monounsaturated** fats have one double bond in each fatty acid
- **polyunsaturated** fats have many double bonds.

Unsaturated fats are thought to be a healthier option in the diet than saturated fats.

Vegetable oils do not dissolve in water. If oil and water are shaken together, tiny droplets of one liquid spread through the other liquid, forming a mixture called an emulsion.

Emulsions are thicker (more viscous) than the oil or water they contain. This makes them useful in foods such as salad dressings and ice cream. Emulsions are also used in cosmetics and paints. There are two main types of emulsion:

- oil droplets in water (milk, ice cream, salad cream, mayonnaise)
- water droplets in oil (margarine, butter, skin cream, moisturising lotion).

**Emulsifiers**

If an emulsion is left to stand, eventually a layer of oil will form on the surface of the water. Emulsifiers are substances that stabilise emulsions, stopping them separating out. Egg yolk contains a natural emulsifier. Mayonnaise is a stable emulsion of vegetable oil and vinegar with egg yolk.

**Emulsifiers- Higher tier**
Emulsifier molecules have two different ends:

- a hydrophilic end - 'water-loving' - that forms chemical bonds with water but not with oils
- a hydrophobic end - 'water-hating' - that forms chemical bonds with oils but not with water.

Lecithin is an emulsifier commonly used in foods. It is obtained from oil seeds and is a mixture of different substances. A molecular model of one of these substances is seen in the diagram.

The hydrophilic 'head' dissolves in the water and the hydrophobic 'tail' dissolves in the oil. In this way, the water and oil droplets become unable to separate out.

**Bromine water test**

Unsaturated vegetable oils contain double carbon-carbon bonds. These can be detected using bromine water (just as alkenes can be detected). Bromine water becomes colourless when shaken with an unsaturated vegetable oil, but it stays orange-brown when shaken with a saturated vegetable fat.

Bromine water can also be used to determine the amount of unsaturation of a vegetable oil. The more unsaturated a vegetable oil is, the more bromine water it can decolourise.

**Hydrogenation- Higher tier**

Saturated vegetable fats are solid at room temperature, and have a higher melting point than unsaturated oils. This makes them suitable for making margarine, or for commercial use in the making of cakes and pastry. Unsaturated vegetable oils can be ‘hardened’ by reacting them with hydrogen, a reaction called hydrogenation.

During hydrogenation, vegetable oils are reacted with hydrogen gas at about 60°C. A nickel catalyst is used to speed up the reaction. The double bonds are converted to single bonds in the reaction. In this way unsaturated fats can be made into saturated fats – they are hardened.
The structure of part of a fatty acid

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