Topic C1.5: Plant oils

Summary

Plants use the energy from sunlight to convert carbon dioxide and water into glucose (sugar) and oxygen by the process of **photosynthesis**.

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2$$

They then convert glucose into other chemicals which are of use to the plant. These chemicals include **oils** which may be extracted from the plant by **pressing** (as with olive oil) or by **steam distillation** (as with many 'essential' oils used in aromatherapy).

Oils and **fats** are an excellent source of **energy** because they produce a high heat output on combustion. In principle, they could be a high energy food but the body is not very good at metabolising (breaking down) such compounds. Molecules which are not metabolised are stored in the body as fat and lead to obesity, heart disease and many other problems. The body is better at metabolising **unsaturated** oils and fats than **saturated** ones. Unsaturated oils contain carbon-carbon double bonds and are able to decolourise bromine water. Vegetable oils contain a higher proportion of unsaturated compounds than animal fats. Consequently, vegetable oils (especially those containing many **polyunsaturated** molecules) are considered to be more 'healthy' than animal fats.

Because saturated molecules pack together better than unsaturated ones they have higher **intermolecular forces** and hence higher melting and boiling points. Thus they are more likely to be solid at room temperature and are known as fats. An oil is simply a fat which is a liquid at room temperature. Both oils and fats have boiling points much greater than water, so foods cooked in boiling oil cook at a higher temperature in a faster time and tend to become crispy on the surface (which cooks the quickest). As they cook, foods absorb cooking oil at the surface and hence become 'fatty'. Unsaturated oils can be **hardened** by reacting with hydrogen gas in the presence of a nickel catalyst at a temperature of 60 ºC. This causes the double bonds to become saturated leading to an increase in melting point. In this way vegetable oil can be converted into margarine – a **hydrogenated** fat. Although solid saturated fats are less healthy, they are essential for cooking certain dishes such as cakes and pastries.

Oils and water do not mix but form two separate layers. However, if molecules known as **emulsifiers** are added to the mixture and then shaken, an **emulsion** is formed in which tiny droplets of oil are uniformly distributed throughout the water. Emulsions are generally opaque and have a smooth, creamy consistency. They have many uses in cooking in the form of sauces, mayonnaise, ice cream, etc. Emulsifiers are a type of food **additive** and can be recognised on food labels by an **E-number** starting with E4…

Another common type of food additive is **colouring**. Artificial food colours have E-numbers beginning with E1… They may be detected and separated by the method of **chromatography**.

Other additives include **preservatives** (E2…) which slow down the process of 'going off', **antioxidants** (E3…) which prevent foods from reacting with oxygen in the air, **acidity regulators** (E5…) which control the pH and **flavourings** (E6…) which give or enhance flavour or aroma. Although approved food additives have been tested for safety, many people distrust them and prefer food to be free of additives. Some people are hypersensitive to certain additives. For example, tartrazine (E102), the orange colour in many drinks, can bring on asthma attacks and is thought to cause hyperactivity in some children.

Vegetable oils are a good source of energy and can be used as **fuels**. **Biodiesel** is made by removing impurities from vegetable oil and can be burnt in normal diesel engines. It is sometimes mixed with traditional diesel fuel. Although it produces carbon dioxide on combustion, it is considered to be more eco-friendly than diesel from crude oil because the plants from which it is extracted absorb carbon dioxide from the air to make the oil in the first place. It also has fewer impurities than traditional diesel and produces fewer pollutants such as sulphur dioxide on combustion. As it is **biodegradable** it poses fewer problems in production and on spillage. Biodiesel is particularly popular in countries with a largely agricultural economy and limited crude oil resources.

Another **bio-fuel** is **ethanol**. This can be made by the **fermentation** of plant sugar in a very low-tech process which requires little energy input. The combustion of ethanol also produces carbon dioxide but this is offset by the carbon dioxide absorbed as the plants produce sugar. In developed countries, ethanol is also produced by the hydration of ethene. This is a much more high-tech process in which ethene (obtained by the cracking of crude oil fractions) is reacted with steam in the presence of a catalyst at high temperatures and pressures. Ethanol produced in this manner is very pure and is more likely to be used as an industrial solvent than as a fuel.