FATS /LIPIDS

Fats are composed of carbon, hydrogen and Oxygen, the same elements as in carbohydrate but in different proportion. They are the most concentrated energy food. Plants store fats in the form of oil droplets or as solid fat. Animals and humans store fat which may be derived from fatty foods or from excess carbohydrates.

Functions of fats

1. Provides a convenient and concentrated source of energy, supplying more energy than the same weight of carbohydrates or protein.
2. Surrounds and protects vital organs, e.g. Kidney
3. Forms an insulating layer (adipose tissue) beneath the skin to help preserve body heat and protect the skeleton and organs.
4. Forms part of the structure of cell membranes throughout the body, especially in the brain.
5. Provides a source of the fat – soluble vitamins A, D, E, K.
6. Provides a reserve of energy for long-term storage which can be used if energy intake is restricted.
7. Provides texture and flavour in food and helps to make it palatable.
8. Foods containing fat provide a feeling of fullness (satiety) after a meal, as fat digestion is slow.

Place of fats in the diet

1. They supply warmth and energy
2. They may be eaten cooked or uncooked
3. Only small amounts are required and are usually found to be most easily digested when accompanied by some carbohydrate food

4. Fats are digested more slowly than other foodstuffs and will therefore slow down the digestion of foods in which fat is included. Hence the feeling of being satisfied is prolonged and hunger is not felt again so quickly as when no fat is present in a meal.
5. Fatty foods lubricate the digestive system to a certain extent.
6. Fats may be used as ingredients of mixtures, particularly as "shortening" in starch mixtures, as accompaniments to other foodstuffs e.g. Salad oil and green salad vegetables, bread and batter), or as the medium for cooking, as in frying.
7. It has a protein sparing action

CHEMISTRY OF FATS

Fats and oils have the same basic chemical structure, but their physical appearances differ at normal room temperature.

Fats are solid at room temperature

Oils are liquid at room temperature.

Fats are composed of the elements

Carbon

Oxygen

Hydrogen

These elements make up molecules of glycerol and fatty acids, which combine to form fat molecules.

Fats and oils are made up of two groups of simple substances

a) **Glycerol** or **glycerine.** A sweety sticky liquid.
b) **Fatty acids**. These are a large variety, about 25 kinds distributed among both animal and vegetable fats.

The fatty acids present determine the consistency of the fat or oil.

eg lard-soft fat – oleic acid.

Beef fat- Hard fat - palmitic acid.

Sources of fat

Animal

Milk fat – cream, cheese, butter and other milk products.

Meat fat- lard, dripping, suet, bacon fat, visible and invisible fat

Egg yolk

Oily fish and fish – liver oils form cod and halibut

Vegetable fats

Nut oils and pulses e.g. peanut etc

Margarine- from Nut, cotton seed and sunflower oils

Olive oil.

Kernels e.g. palm etc

Fruits e.g. avocado pear.

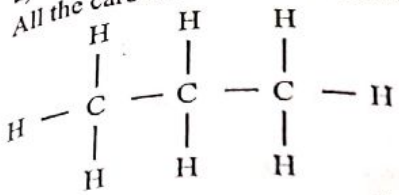
Other examples include sausages, fried foods, and all cooking oils.

Classification of Fats / lipids / Triglycerol

They may be either saturated or unsaturated, according to the way in which their carbon and hydrogen atoms are arranged.

a) **Saturated fatty acids**

All the carbon atoms are saturated with hydrogen atoms and cannot accept any more



Examples	found mainly in
Butyric acid	milk, butter
Palmitic acid	animal fats
Lauric acid	dairy foods, coconut oil
Stearic acid	beef fat

Fats that are solid at room temperature are mostly made up of saturated fatty acids

b) **Unsaturated fatty acids**

Some of the carbon atoms are joined to others by a **double bond** and so are not completely saturated with hydrogen atoms. They could therefore **accept** more hydrogen atoms

These are further divided into

i) **Mono unsaturated.** Fatty acids have **one** double bond in the molecule e.g. oleic acid, found in most animal and plant fats and oils especially olive oil.

Different combinations of fatty acids combine with glycerol to form a wide variety of fat molecules.

Polyunsaturated fatty acids have **more than one** double bond in the molecule, e.g. linoleic acid linolenic acid ;both found mainly in vegetable oils; Arachinodenic acid - cod liver oil

Energy value

1gram of lipid produces over 9 kilocalories (37kilo joules) upon break down (digestion) compared with the average 4 kilocalories (16kilojoules) released by carbohydrates or proteins.

Intake of fat in the diet

Approximately 30% of the total calories for energy regulation usually come from fat.

Approximate daily intake of kilocalories is 3000

Visible and invisible fat

Fat is present in food either as visible or invisible fat.

Visible fat. Is easy to detect in food:

Examples;

Fat on meat

Butter, margarine, lard, suet.

Cooking fats and oils.

Invisible fat is a constituent part of food, and is difficult to detect.

Examples;

Lean meat – fat within muscle (marbling)

Egg yolk

Flesh of oily fish.

Nuts, seeds, fruits.

Prepared foods e.g. pastry, cakes, biscuits

Fried foods and fritters, croquettes.

Sources of fat in the diet

1) Fat content of protein rich foods e.g. milk, cheese, eggs, meat and fish (oily)

2) Fat content of made up dishes – cakes and puddings
3) Fat used for cooking
4) Fat served with carbohydrates foods e.g. butter with bread.

Fat requirements in the body

- **Essential fatty acids (EFA's).** These are fatty acids that the body requires but cannot make them itself.
  Examples include – Linoleic acid, - Linolenic acid which are found mainly in plant oils. They are needed for the brain development of babies. There are found in breast milk, and it is one reason why human breast milk is best for babies.
- Oily fish (e.g. herrings, sardines, Mackerel) contain essential fatty acids called **Omega 6** and **Omega 3**. Omega 3 essential fatty acids may help
  i) Lower the **blood cholesterol**
  ii) Help prevent **blood clots**
  For these reasons it is recommended that people eat two portions of oil fish per week.

Effects of deficiency

1. Fat deficiency alone has no particular symptoms, but if the total intake of energy foods is too little, there will be weight loss progressing eventually to starvation.
2. Lack of essential fatty acids leads to debility and a build –up of cholesterol in the blood.
3. Symptoms of fat –soluble vitamin deficiency may occur when there is a restricted intake of fat.

Dietary problems

a) Over indulgence in fatty foods or foods cooked in fat may lead to obesity
b) Animal fats are often difficult to digest. Exceptions are milk and eggs where the fat is dispersed in a fine emulsion.
c) Saturated fats are thought to make cholesterol accumulate in the coronary arteries causing arteriosclerosis. (heart -related -diseases)

Effect of heat

1. When heated, solid fats **melt** to become liquid oils
2. As heating continues, the oil becomes **thinner**, and begins to **bubble**
3. At very high temperatures, fats **decompose** into glycerol and fatty acids.

A blue haze is produced, and then **smoke** and soon after this, the fat **ignites** and **burns** rapidly.

4. Fried foods readily absorb fat and this increases their energy value.

Effects of heat on Fats / properties of fats

1. **Smoke point: (200^0C-250^0C).** This is the temperature /point when the fat is heated, giving off a thin bluish haze of smoke, which will give food an unpleasant flavour. At this temperature the fat molecules start to split up, reducing the keeping qualities of the fat.
2. **Flash point.** This is the temperature at which the fat will ignite and burn fiercely. It occurs when further heating is done.

Fat	Smoke point(when fresh)
Vegetable oil	227-232^{0}C
Lard	183-205^{0}C
Vegetable fat	180-188^0 C

Anti spattering agents such as the emulsifier lecithin may also be used to lower the smoking temperature of fats and oils.

3. **Solubility.** Fats and oils are insoluble in water but will dissolve in organic solvent such as ether and benzene.

4. **Emulsions.** This is the ability of fats and oils to form colloidal solutions, e.g. oil in water and water in oil. **Stabilizers** are substances such as pectin, starch and gelatin which help to maintain an emulsion once it is formed.
5. **Plasticity.** This is the ability of solid fats to form a **lattice structure** of minute crystals which are surrounded by fat molecules. This enables the crystals to move about slightly, giving them a plastic or pliable texture i.e. Fats are spreadable and respond to pressure and friction (e.g. creaming or Rubbing in with the fingers).
6. **Hydrolysis.** This occurs when triglycerides react with water to form glycerol and fatty acids. This process is used commercially for rendering down animal fats by heating them under pressure.
7. **Saponification.** When a fat molecule is hydrolyzed with an alkaline i.e. (the reaction between fat molecules and an-alkali) salts for the fatty acids (soaps) and glycerol are produced. This is known as saponification or Soap making. The reaction is **hastened** by boiling.
8. **Hydrogenation.** This is a chemical process whereby unsaturated oils are converted into solid fats by forcing hydrogen gas through them. The unsaturated carbon atoms in the fatty acids molecules take up the hydrogen, becoming saturated in the process.
   Reaction
   Unsaturated molecule + Hydrogen $\longrightarrow$ Saturated molecules
   The reaction is speeded up by the use of **Nickel** which acts as a catalyst. The process is used in the manufacture of margarines.
9. **Melting points.** The higher the degree of saturation, the higher the melting point of the lipid /fat i.e. Due to the type of fatty acids they contain. In general, the more **saturated** fatty acids a fat contain the more solid it will be, and the more **unsaturated** fatty acids it contains, the more **liquid** it will be at room temperature.
10. **Rancidity.** This is when fats and oils, and foods containing them, develop off flavours and odours due to the fat becoming **rancid.**
    Rancidity is caused by the action of the enzyme **lipase** or by **oxidation**
    Enzyme lipase breaks down the fat molecules, and the off flavours and odours develop because of the free fatty acids in the food.
    Heat can destroy both lipase and the Micro- organisms in the food that produce lipase.

TYPES OF RANCIDITY

i) Hydrolytic rancidity

Caused by the glycerol splitting from the fatty acids. The smell of rancid fat depends on the fatty acid present e.g. in Rancid Butter.

ii) Oxidative rancidity

The breakdown of particular fatty acid in reaction with Oxygen with the release of substances that have an unpleasant taste and smell.

In oxidative, Oxygen is absorbed by the fat and reacts with the fat molecules to produce substances that give the fat an unpleasant flavour and odour.

Oxidative rancidity is accelerated (fastened) by:

i) Presence of light
ii) Impurities in fat
iii) Enzymes
iv) Presence of many poly unsaturated fatty acids

Antioxidants are added to foods containing fats to prevent light from reaching them Rancidity can develop in fat – containing foods that are kept in cold storage or frozen.

Refining

Oils and fats in their raw state are soft strong smelling with an unpleasant taste and appearance. Before use they must be extracted and refined.

Vegetable oils are refined by:

i) Neutralizing with caustic soda to remove acid impurities
ii) Bleaching or decolourising with fuller's earth or charcoal.
iii) Filtering to remove solid impurities
iv) Deodorizing by steam distillation to remove strong smells.

Digestion and absorption of fats

a) **Mouth**

Physical breakdown

Teeth, tear, rip and grind the food into pieces small enough to swallow.

Tongue pushes the food round the mouth and down the throat. **Salivary** glands produce saliva to moisten food and make it easy to swallow.

Chemical Breakdown

Fat breakdown is absent

b) **Oesophagus**

Food is transported down to the stomach by **peristalsis.** There is no physical or chemical breakdown here

c) **Stomach**

Physical breakdown

Food enters the stomach via the sphincter muscle at the top. Strong muscular waves move the food around and help to break it down and mix it with gastric juices and Mucus produced in the stomach. The broken- down food is referred to as **Chyme.**

Chemical breakdown

Fat breakdown is absent here

d) **Duodenum**

Physical breakdown is absent

Chemical breakdown

The chyme is mixed with bile from the gall bladder and pancreatic juices from the pancreas. Bile neutralizes the acid and stops the action of pepsin.

Fat,: Bile emulsifies fats to disperse them in the liquid in small droplets, and pancreatic lipase breaks fat into **soluble glycerol** and **insoluble fatty acids.**

The fatty acids react with the bile to become soluble.

e) **Ileum**

Physical breakdown is absent here

Chemical breakdown

Further fat break down by lipase enzyme occurs.

Absorption of fats

Glycerol and fatty acids are absorbed into the lacteals where they recombine to form fats, which mix with the lymphatic fluid.

They then pass round the body in the lymphatic systems and join the blood circulation as insoluble fat.

They are converted to soluble fat in the liver.

VITAMINS

Vitamins are complex organic chemical substances which are usually obtained by the body from food. They do not produce energy and therefore have no calorific value.
Vitamins are required by the body in very small amounts but if these are not included in the diet various deficiency diseases will occur.

General Function

1. Vitamins are required to regulate the maintenance and growth of the body, and to control metabolic reactions in cells.

Classification

Vitamins can be classified according to the substances in which they dissolve
There are two groups

1. **Fat – soluble –vitamins : vitamins A, D, E and K**
2. **Water – soluble vitamins: vitamin C and the Vitamin – B- complex.**

FAT SOLUBLE VITAMINS

Vitamin A (Retinol)

Functions

1. Required to make a substance called visual **purple**, which is formed in the retina of the eye to enable it to see in dim light i.e helps in satisfactory perception of light.
2. Necessary for health of mucous membranes in linings of the throat, digestive, brochial and excretory systems by keeping them moist and free from infection.
3. Required for the maintenance and health of the skin.
4. Required for the normal growth of children, particularly the bones and teeth
5. It offers protection against heart disease and some forms of cancer

Sources

Animal source (Retinol)

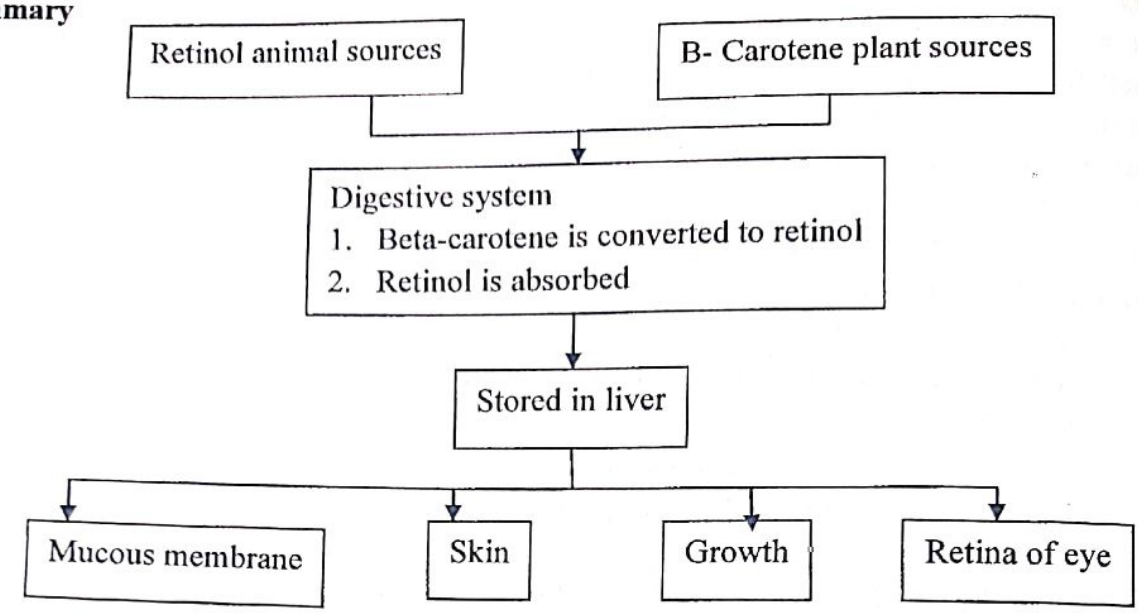
- Milk and milk products
- Liver
- Cheese
- Kidney
- Egg yolk
- Cod and halibut liver oil
- Butter
- Oily fish e.g. herring, pilchard, sardine
- Margarine (Fortified)

Plant sources (Beta – carotene)

- Carrots
- Cabbage
- Tomatoes
- Prunes
- Spinach
- Watercress
- Apricots
- Parsley

Vitamin A gives plants their orange/yellow colour, although in green vegetables, the colour is masked by green chlorophyll.
In the body Beta- carotene is converted to retinol and two parts of Beta – carotene form one Retinol.

Summary



Requirement

1. Vitamin A is fat – soluble, it can be stored in the body mainly in the liver, so a daily supply is not always necessary.
2. Too much vitamin A in the diet is poisonous, as it is stored in the body, and can seriously affect skin and joints, especially in children.
3. Pregnant women are advised not to eat liver, because it contains very high amounts of retinol which could lead to damage and defects in the unborn baby.
4. Too much vitamin A results in pain in bones, nausea, and loss of hair and enlargement of the liver.
5. Beta – carotene does not cause harm in this way, so it is advisable for pregnant women to eat plenty of fresh fruit and vegetables, in order to receive the extra vitamin A that they need.

Special requirements

1. Children, need plenty for growth and development
2. People who cannot digest and absorb fat well, many need a vitamin A injection to overcome this.

Results of deficiency

1. Night blindness or inability to see in dim light. The retina ceases to make visual purple. In severe cases the structure of the eye deteriorates and eventually ruptures, causing total blindness.
2. The skin and Mucous membranes become dry and infected.
3. Resistance to disease is reduced
4. Growth of children is reduced.

Effects of excess vitamin A

1. High amount could lead to damage and defects in the unborn baby.
2. Too much vitamin A in the diet is poisonous and can affect skin and joints, especially in children.
3. Over doses can be responsible for definitely unpleasant symptoms of impaired fitness.
4. Also excess of vitamin A results in pain in the bones, nausea, loss of hair and enlargement of the liver.