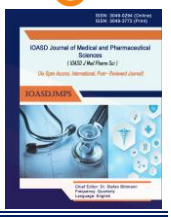
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Fatty Acids: Classification, Metabolism, Biological Functions, and Implications for Human Health

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ABSTRACT

Fatty acids are important lipid molecules, playing vital roles in the body. They are a key component of triglycerides, phospholipids and complex lipids. Depending on their chemical structure, they can be classed as saturated, monounsaturated or polyunsaturated fatty acids. Fatty acids act as a concentrated source of energy, are involved in cell membrane structure and play a role in brain development. Fatty acids also play a role in inflammation and hormones. They are digested, absorbed, transported and stored in the body. Essential fatty acids, such as omega 3 and omega 6 fatty acids, are important nutrients that must be eaten from the diet. Imbalances in fatty acid intake can lead to obesity, cardiovascular disease, insulin resistance and inflammatory diseases. This article will discuss the classification, metabolism, role in the body, sources and impact on health.

Keywords: Fatty acids, Saturated fats, Unsaturated fats, Omega 3, Omega 6, Lipid metabolism, Cardiovascular.

Review Article

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1. INTRODUCTION

Fatty acids are organic molecules composed of a hydrocarbon chain and carboxyl group. They are an integral component of fats in the diet and cell membranes. They play a role in energy storage, cell signaling, maintaining cell structure and metabolic regulation. They are usually sourced from fats in the diet or can be synthesized within the body.

Depending on the length of the carbon chain and the amount and position of double bonds, fatty acids have different properties. They are important nutrients involved in energy production, growth, brain development and cardiovascular function. A balanced intake of fatty acids in the diet is important for metabolic health [1,2].

2. Classification

Fatty acids can be divided into:

2.1 Saturated Fatty Acids

Saturated fatty acids have no double bonds between carbons. They are commonly found in animal fats, butter, dairy products, coconut oil and palm oil. Examples are palmitic acid and stearic acid. High intakes of saturated fatty acids can increase levels of low-density lipoproteins in the blood if replacing unsaturated fats.

2.2 Monounsaturated Fatty Acids

Monounsaturated fatty acids have one double bond between carbons. Oleic acid can be found in high concentrations in olive oil. They can also be found in avocado, nuts and seeds. They can improve blood lipid profiles by replacing saturated fats.

2.3 Polyunsaturated Fatty Acids

Polyunsaturated fatty acids have multiple double bonds. These include omega 3 and omega 6 fatty acids.

Omega 3 Fatty Acids: These include alpha linolenic acid (ALA), eicosapentaenoic acid (EPA) and

docosahexaenoic acid (DHA). They can be sourced from fatty fish, flaxseed, chia seed and walnuts.

Omega 6 Fatty Acids: Linoleic acid (LA) and arachidonic acid (AA). They can be found in sunflower oil, soybean oil, corn oil and nuts/seeds.

Linoleic acid and alpha linolenic acid are essential fatty acids as they cannot be synthesised by the body and must be eaten from foods [1,3].

3. Digestion, Absorption and Transport

Fats from the diet are mainly digested in the small intestine. Bile salts will emulsify large fat droplets into smaller ones so there is a greater surface area for pancreatic lipase to act upon. Pancreatic lipase will break down triglycerides into free fatty acids and monoacylglycerols.

These will form mixed micelles with bile salts and be transported to the epithelial cells of the intestine. Inside the enterocytes, the long chain fatty acids will be esterified into triglycerides. They will then be packaged into chylomicrons and transported into the lymphatic system. In the bloodstream, lipoprotein lipase will break down the triglycerides inside the chylomicrons to release fatty acids for uptake by muscle and adipose tissues. Fatty acids can also be transported in the blood via albumin, especially during fasting and adipose tissue breakdown [2,4].

4. Metabolism and Energy

Fatty acid oxidation is an important source of energy. It occurs during fasting, long periods of exercise and when fewer carbohydrates are available.

The main way fatty acids are broken down is via beta oxidation. This occurs mainly in the mitochondria. The long chain fatty acid will first be activated into fatty acyl-CoA in the cytoplasm or on the outer mitochondrial membrane. It will then enter the mitochondrial matrix via the carnitine system. This includes carnitine palmitoyltransferase I, carnitine-acylcarnitine translocase and carnitine palmitoyltransferase II.

Within the mitochondria, the fatty acid will undergo beta oxidation. This includes:

- Oxidation to form FADH2.
- Hydration to add water.
- Oxidation to form NADH.

Thiolysis to produce acetyl-CoA and shorten the fatty acyl-CoA chain by two carbons.

Acetyl-CoA will enter the tricarboxylic acid cycle. NADH and FADH2 will help produce ATP via oxidative phosphorylation. Fatty acid oxidation provides a large source of energy to tissues such as skeletal muscles, heart and liver [2,4].

5. Role in the Body

Fatty acids have many roles in the body, including:

- Energy storage: Stored in triglycerides as concentrated metabolic energy.
- Cell membrane structure: Fatty acids in phospholipids affect membrane fluidity, permeability and cell function.
- Brain development: DHA plays a role in neuronal membranes and normal vision and brain development.
- Inflammation: Omega 3 and 6 fatty acids act as precursors for signalling molecules.
- Hormones: Fatty acid derived molecules help regulate blood vessel function, platelet function and inflammatory pathways.
- Thermoregulation: Adipose tissue helps control body temperature and protect internal organs.

6. Role in Human Disease

Abnormal fatty acid intake and metabolism can lead to several diseases.

- Obesity: High energy intakes and increased triglyceride storage lead to increased adipose tissue. Fatty acid metabolism has a close relationship with insulin sensitivity.
- Cardiovascular disease: Replacing saturated fats with polyunsaturated and monounsaturated fats can improve lipid profiles. Trans fats from industry should be avoided.
- Type 2 diabetes: High levels of free fatty acids in circulation may cause insulin resistance.
- Inflammatory diseases: Omega 3 and 6 fatty acids produce active lipid molecules that affect inflammation. This depends on the fatty acid, molecule, tissue and metabolism [3,5].

7. CONCLUSION

Fatty acids are essential molecules involved in energy production, cell membranes, cell signalling and metabolic regulation. They can be classed into saturated, monounsaturated or polyunsaturated. They are digested, absorbed, transported and broken down via beta oxidation to ensure energy is available to help carry out normal cell functions. Essential fatty acids such as omega 3 and 6 must be eaten from the right sources. Having a balanced intake of fatty acids by replacing saturated and trans fats with unsaturated fats will improve metabolic and cardiovascular health. Understanding fatty acid metabolism is important for nutrition, preventing disease and understanding human physiology.

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