Essential Fatty Acids

Technical Background

- Fatty acids are long chain carbon compounds that have a non-polar carbon tail, and a polar head. The free fatty acids are almost never found in the body. They are utilized either as fats (triglycerides) or phospholipids.

- Our bodies accumulate triglycerides in fat deposits for a source of stored energy. Phospholipids are very similar to triglycerides and form a double layered membrane that surrounds every cell in our bodies. The health and function of each cell is highly dependent on the structure of this phospholipid bilayer.

- Our bodies can produce most fatty acids from the carbohydrates that we eat. However, there are two fatty acids, called essential fatty acids, that we cannot produce and must be obtained from dietary sources. These two acids are Linoleic Acid (LA) an omega-6 fatty acid, and \( \alpha \)-linolenic acid (LNA) an omega-3 fatty acid.

- If dietary sources of EFAs are low, and saturated fatty acid intake is high, the cell membrane will incorporate the saturated fatty acids into its phospholipid bilayer, which causes the membrane to become rigid. When EFAs are incorporated in the cell membrane, it becomes more fluid and this allows many important transport functions to occur.

- LNA is the starting material for the biosynthesis of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), two important polyunsaturated fatty acids (PUFAs) found preformed in fish oils. LNA, EPA and DHA are the main members of the omega-3 family of fatty acids.

- The essential fatty acids are also converted in our bodies (through AA, or EPA) into two important classes of eicosanoids, leukotrienes and prostaglandins. These later compounds are hormone-like substances that influence a huge number of metabolic processes.

- Omega-3 fatty acids found in fish have a positive effect on various risk factors such as high blood pressure, and triglyceride and cholesterol levels. The omega-3 acids may also help reduce damage to the blood vessels from abnormal blood clotting (thrombosis) and fatty deposits (atherosclerosis).

- Omega-3 EFAs are also important for anyone subject to inflammatory stress. Diets high in omega-6 acids produce high levels of arachidonic acid (AA) which is metabolized into prostaglandins (PGs) and leukotrienes (LTs), compounds which have pro-inflammatory activity. Addition of the omega-3 acid LNA to these diets drives the metabolism of compounds, which have a much lower inflammatory potential.

- EFAs are very important for brain development and mental function because the membranes of nerve cells are especially high in omega-3 fatty acids. Some children diagnosed with ADD have shown positive results when they are given EFA supplements.
Sources and Recommended Intake.

- The main sources of omega-3 PUFA in our diets are from fatty fish and green leafy vegetables (cabbage, spinach, broccoli, lettuce, etc.). Unprocessed vegetable oils are rich sources of EFAs. The richest source of the omega-3 EFA alpha-linolenic acid is from unrefined flax oil. This oil contains 55-60% LNA. Many commercial oils (corn, soybean, and canola) contain very low amounts of ω-3 EFAs.

- In the US and in Europe, the daily dietary amount of omega-3 fatty acids has dropped by over 200 percent from traditional diets. Essential fatty acids are largely absent from our diets because of refining and hydrogenation processes used for commercial vegetable oils. This processing is used to remove EFAs and PUFAs, which are easily oxidized, making the oils rancid. Oils are hydrogenated to make them solid, i.e. margarine and shortenings are fully hydrogenated. This hydrogenation step removes all remaining EFAs.

- Fish, and fish oils contain the EPA and DHA, which are produced from EFAs.

- No definite recommendations exist for the intake of omega-3 and omega-6 EFA. However, many studies have recommended that our diets should contain 10 - 20 g per day of LA and 3 - 5 g of LNA. Most western style diets contain 10 -15 g LA, but only 0.5 - 1 g per day of LNA.

Abstracts

**Horrobin DF. Essential fatty acids in the management of impaired nerve function in diabetes. Diabetes 1997 Sep;46 Suppl 2:S90-3.** Impaired conversion of linoleic acid to gamma-linolenic acid (GLA) has been demonstrated in animal diabetes and inferred from blood fatty acid profiles in human diabetes. This impairment could theoretically lead to defective nerve function because metabolites of GLA are known to be important in nerve membrane structure, nerve blood flow, and nerve conduction. Administration of GLA corrects the impaired nerve function in animal models of diabetes. Two multicenter, randomized, placebo-controlled trials in humans with diabetic neuropathy have shown significant benefits of GLA as compared with placebo in neurophysiological parameters, thermal thresholds, and clinical sensory evaluations. Further work is needed to define the place of this therapeutic approach and its interactions with other treatment modalities.

**Konig D, Berg A, Weinstock C, Keul J, Northoff H. Essential fatty acids, immune function, and exercise. Exerc Immunol Rev 1997;3:1-31.** The immunologic response to exercise comprises numerous alterations within the immune system, but how these processes are regulated is still largely unknown. Exercise-related immunological changes include signs of inflammation, such as release of inflammatory mediators, activation of various white blood cell lines and complement, and induction of acute phase proteins. Nevertheless, signs of immunosuppression, such as decreased T and B cell function or impaired cytotoxic or phagocytic activity, can also be observed. Some data suggest that essential fatty acids help regulate inflammatory processes, modulating both cytokine release and the acute phase response. Positive effects of changing dietary essential fatty acids have been demonstrated in chronic inflammatory diseases. In contrast, little is known about the contribution of fatty acids to the exercise-induced immunologic reaction. Essential fatty acids may determine alterations within the immune system following exercise. Therefore, future studies are necessary to evaluate the influence of the fatty acid composition on the inflammatory or immunosuppressive component following heavy exertion.

References