

Zooplankton and their protective effects on cardiovascular diseases

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Abstract

In the world-wide cardiovascular diseases are the most common. And mortalities are high. Many modifiable and non-modifiable risk factors for cardiovascular diseases have been identified. One of them is diets. In diet polyunsaturated fatty acids such omega-3 and omega-6 have protective effects on cardiovascular health. Polyunsaturated fatty acids are essentials for humans, have taken from foods. Fish and fishkind productions have polyunsaturated fatty acids. Polyunsaturated fatty acids are synthesized by zooplanktons and pytoplanktons. In food chain Zooplanktons have important place. Zooplankton is the nutrients of fish. Fishes constitute the store of polyunsaturated fatty acids for people. We see how important zooplanktons are in the first steps of the food chain for humans.

Keywords: Zooplankton, Cardiovascular diseases, Coronary heart disease, Human health

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Introduction

Cardiovascular diseases (CVDs), particularly coronary heart disease (CHD), account for the major causes of mortality worldwide (Zapolska *et al.*, 2015). Most CVDs are associated with the development of atherosclerosis, which is a chronic systemic inflammatory disease that affects artery walls due to altered inflammatory response. Cholesterol-rich lipoproteins with apolipoprotein B are susceptible to absorption and binding to the arterial subendothelial matrix. In this matrix, lipoproteins are altered by oxidation, enzymatic and non-enzymatic cleavage, and aggregation, producing pro-inflammatory particles and activating the overlying endothelium. Thereafter, the recruitment of monocyte derived cells to the subendothelium activates immune response. These cells transform into mononuclear phagocytes that engulf normal and altered lipoproteins and transform into cholesterol foam cells which remain in the plaque, take up lipids, and engorge and stimulate disease progression by developing chronic inflammatory response (Moore *et al.*, 2013; Tall *et al.*, 2015).

CVSs and polyunsaturated fatty acids

In CVSs there are lots of risk factors one of them is diet. In CVDs diet plays a key role. Good cardiovascular health status is related to a balanced energy intake including whole-grain foods, legumes, seafood and fish, and high content in fruits and vegetables and low intake of processed food and red meat,

sugar added foods or beverages and refined grains.

Among polyunsaturated fatty acids (PUFAs), the most important classes are the omega-3 (ω -3) and omega-6 (ω -6) fatty acids (FA). PUFAs present two or more double bonds between carbons within the fatty acid chain. It is possible to distinguish several different ω -3 PUFA: α -linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) (Manson *et al.*, 2018). The major ω -6 PUFA are linoleic and arachidonic acid (AA). Essential FA, ALA and linoleic acid, are obtained from the diet (flaxseed, soybean, and canola oils) (Erdman *et al.*, 2012; Coates, 2010). In the liver ALA is converted into EPA and then DHA (Coates, 2010). Both EPA and DHA can be directly obtained through diet (fish, fish oils, and krill oils) or dietary supplements and are also found in ω -3 fortified foods such as eggs, dairy products, pastas, cereals, breads and oils, among others (Bowen *et al.*, 2016).

There is currently a large amount of scientific evidence demonstrating the utility of marine-derived ω -3 PUFA supplements in the prevention of CVD. A great number of mechanisms have been related to the anti-inflammatory actions of ω -3 PUFA in atherosclerosis. Different mechanisms have been proposed in an attempt to explain the cardioprotective effects of ω -3 PUFA. On one hand, ω -3 PUFA may improve the lipid and lipoprotein profile and endothelial function, and down-regulate the expression of leukocyte cells and the concentrations of various pro-

inflammatory biomarkers related to the development of atherosclerosis such as chemokines, cytokines or soluble adhesion molecules as well as markers related to plaque stability such as metalloproteinases (MMP). There is evidence suggesting that a higher intake of ω -6 fats, together with a lower intake of saturated fat may reduce the incidence of CHD. On the other hand, a large body of literature has suggested that a higher intake of ω -6 may promote inflammation and contribute to the pathogenesis of many diseases, including CVD, because AA promotes the synthesis of a variety of pro-inflammatory eicosanoids. There is not enough evidence related to the harm or the benefit of ω -6 on CVD, and more concretely, on atherosclerosis.

Zooplankton and food webs

There are many living organisms in the marine habitat such as phytoplankton, zooplankton. Phytoplankton is the main manufacturers' constituents of organic materials in both fresh waters and marine. Oxygen released by phytoplankton as a result of photosynthesis life is a vital part of the system that supports. At the same time phytoplankton do constituting the basic nutrients for zooplanktons, increases the importance of water in the fold.

For most marine organisms, lipid fatty acids (FA) are the main form of energy storage for growth and survival, particularly during times of food shortage. Fatty acids are important in membrane structure, energy metabolism, hormone precursors, and, when combined with proteins, as

intracellular messengers (Storch and Thumser, 2010). The composition of total FA in marine algae varies in different growth phases (Tonon, 2002), in different physiological states, and with environmental conditions, such as temperature (Thompson, 1992), pCO₂ (Gordillo *et al.*, 1998), nutrient concentrations (Reitan *et al.*, 1994), and light intensity (Thompson *et al.*, 1990). A subset of these fatty acids is the nutritionally important long chain polyunsaturated fatty acids (PUFA), the essential fatty acids (EFA), are synthesized exclusively by phytoplankton (Brett and Müller-Navarra, 1997). EFA are critical constituents in the diets of zooplankton and higher trophic levels. Feeding on algae rich in PUFA markedly increases zooplankton growth rates, highlighting the important roles that phytoplankton PUFA have in the marine food web (Kainz *et al.*, 2004). Diets rich in PUFA are essential for egg production in copepods (Jónasdóttir *et al.*, 2009) as well as in fish growth and reproduction (Watanabe, 1982; James Henderson and Tocher, 1987). Understanding the processes which regulate the efficiency of energy transfer and thus food-quality is a critical challenge confronting the study of aquatic foodwebs. These processes strongly influence fisheries production and biogeochemical cycling in freshwater and marine ecosystems (Sterner and Hessen, 1994).

Zooplankton is a kind of heterotrophic plank, ranging from microscopic organisms to large species such as jellyfish. Zooplankton is found

in large water bodies, including oceans and freshwater systems. Zooplankton drives ecologically important organisms, an integral part of the food chain. The most important zooplankton species include radiolarians, foraminiferans and dinoflagellates, cnidarians, crustaceans, chords and molluscs. Zooplankton consumes various types of bacterioplankton, phytoplankton and even other zooplankton. Since such organisms are found on the surface of water bodies, zooplankton is usually found in the upper waters. Zooplanktonic organisms are the main food source of many fish in larval stage (Wetzel, 2001). Zooplanktonic organisms, which have important role in fresh water ecosystems, are generally used as an indicator in determining the trophic condition of the water quality, and in eutrophication (Michaloudi *et al.*, 1997; Bozkurt and Akin, 2012). Fish protein is, of course, of high nutritional value but in the last two decades' emphasis on the nutritional value of fish to vertebrate animals and especially to humans has shifted towards fish oils and specifically towards the long-chain PUFA in fish oils, namely DHA and EPA. PUFA of the n-6 series have long been known to be essential dietary constituents for man for example AA. The long-chain ω -3 PUFA DHA and EPA are also essential for many bodily functions in vertebrates including man. These fatty acids can either be delivered directly from the diet or produced within the body from linolenic acid (LNA, 18:3n-3), it self-consumed directly in the diet.

ω -3 PUFA in fish oils originate in marine phytoplankton. ω -3 PUFA are transmitted from phytoplankton via zooplankton to fish. The transmission of fatty acids through marine food webs has recently been reviewed by Sargent and Henderson (1995) and Sargent *et al.* (1995b) (Sargent and Henderson, 1995; Sargent, 1996). Marine zooplankton retains the ω -3 PUFA ingested in their phytoplankton diet, mostly 20:5n-3 and 22:6n-3, in the phospholipids of their cellular membranes and they also store these fatty acids in their neutral oil reserves. However, marine zooplankton can produce a range of fatty acids, including the long-chain monounsaturated acids 20:1n-9 and 22:1n-11 that is not present in phytoplankton, and also stores these fatty acids in oil reserves.

Fatty acids may act as both dietary tracers in the food web and indicators of overall food quality (Iverson *et al.*, 2004). The majority of organisms need specific dietary fatty acids for somatic development and fitness (Masclaux *et al.*, 2012).

These fatty acids, ALA, and LA, are labeled essential fatty acids because they cannot be directly synthesized by heterotrophic organisms and must come from the diet (Arts *et al.*, 2009). Polyunsaturated fatty acids EPA, DHA, and AA are required for all organisms and play a role in health and cell function (Dalsgaard *et al.*, 2003). Thus, an organisms' fatty acid signature may indicate dietary consumption and nutritional quality of its prey (Goncalves *et al.*, 2012).

Conclusion

Diet is one of the most important causes of cardiovascular diseases in the world. Polyunsaturated fatty acid ratios in diets are very important for cardiovascular health. PUFA synthesis in the food chain is performed by phytoplankton. Phytoplankton are in the food group of zooplankton in the food chain. And also zooplankton is also a fish food. It is of great importance in human nutrients like because of the nutrient content of fish. The source of ω -3,6PUFA in fish originates from zooplankton. The source of omega 3 and 6, which is very valuable for the health of the people we understand here, is met indirectly from zooplanktons. We see how important zooplanktons are in the first steps of the food chain for humans.

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