

SEAWEED AS A DIETARY FIBER TO PREVENT THE CARDIOVASCULAR DISEASE

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Abstract

Indonesia has a lot of potential in natural resources, one of which is seaweed. Seaweed is one of the natural ingredients that contain water-soluble dietary fiber. The fiber content in seaweed can be categorized as a functional food. The fiber content in seaweed varies, from 36-60% dry weight, 55-70% of the former percentage is soluble fiber consisting of alginate and carrageenan with varying amounts depending on the type of seaweed and environmental conditions. The dietary fibers are useful for disease prevention and health maintenance. Dietary fiber can prevent several diseases, including coronary heart disease (cardiovascular). The effect of dietary fiber according to Liu et al (2002) is a very high fiber diet (55 g/1,000 kcal) which resulted in a 33% reduction in LDL cholesterol (Low-Density Lipoprotein) in two weeks period. The mechanism of dietary fiber reduces cardiovascular disease since it is able to bind bile acids (the end product of cholesterol), thereby preventing its reabsorption from the intestine. Cholesterol that is bound to bile acids and lignin/pectin cannot be absorbed by the intestines but will be excreted in the feces.

Keywords: seaweed, dietary fiber, cardiovascular, cholesterol

Introduction

Seaweed that is mostly produced by Indonesia is *Gracilaria* as the raw material for agar and *Eucheuma cottonii* for carrageenan. These species are cultivated mainly in the Riau Islands, Lampung, Kepulauan Seribu, Bali, Lombok, Flores, Sumba and Sulawesi. The utilization of seaweed can produce 500 types of commercial products, including carrageenan, which is the raw material for cosmetics, perfumes, medicines, and toothpaste. Indonesia currently ranks fourth after Chile, Morocco and the Philippines as the world's main producers of seaweed (Bureau of Micro, Small and Medium Enterprises Development, 2008).

The potential of seaweed resources must be followed by adequate seaweed quality control since this will affect the quality of seaweed raw materials. According to (Eniati, 2016), the low quality of Indonesian seaweed is caused by the absence of special standards applied at the farmer level. Starting from the planting process to post-harvest control, causing the low quality of the seaweed raw materials produced. The quality of seaweed raw materials will affect the

bioactive content. Likewise, the quality of seaweed raw materials that are controlled well in the process can become a functional food product. The development of seaweed-based functional food products will able to provide broad access for the community to the provision of healthy food (functional food) at affordable prices.

Seaweed is one of the natural ingredients that contain water-soluble dietary fiber. Astawan et al. (2006) suggested that *Eucheuma cottonii* type seaweed from Indonesian waters contains soluble fiber up to 23.89% and insoluble dietary fiber of 55.05%. The fiber content in seaweed varies, namely 36-60% in dry weight, of which 55-70% is soluble fiber consisting of alginate and carrageenan with varying amounts depending on the type of seaweed and environmental conditions. Furthermore, fucoidans, laminarin, porphyrin, and Ulvan are also soluble fibers that are widely found in several types of seaweed (Rajapakse and Kim, 2011).

Table 1. Several types of soluble fiber in seaweed.

Several types of soluble fiber in seaweed. Dissolved fiber (hydrocolloid)	Source
Agar	<i>Eucheuma cottonii</i> (<i>gracilaria</i> , <i>gelidium</i> , <i>pterocladia</i>)
Carrageenans	<i>Eucheuma cottonii</i> (<i>eucheuma</i> , <i>chondrus</i> , <i>hypnea</i> , <i>gigartina</i>)
Alginate	<i>Phaeophyceae</i> (<i>macrocystis</i> , <i>laminaria</i> , <i>Ascophyllum</i>).
Fucoidan	<i>Phaeophyceae</i> (<i>laminaria religiosa</i> , <i>nemacystus decipiens</i>)
Laminarin	<i>Phaeophyceae</i> (<i>laminaria japonica</i> , <i>saccharina latissima</i>)
Porphyran	<i>Eucheuma cottonii</i> (<i>Porphyra spp</i>)
Ulvan	<i>Chlorophyta</i> (<i>Ulva lactuca</i> , <i>enteromorpha spp.</i>)

Source: Rajapakse (2011)

Seaweed has great potential as a raw material source of dietary fiber. The total fiber content of seaweed is relatively higher when compared to sustenance derived from land plants (tubers, fruit, cereals, and nuts) (Dwiyitno, 2011).

Result and Discussion

Dietary Fiber

Dietary fiber is the edible part of plants or analogous carbohydrates that are resistant to digestion and absorption in the small intestine with complete or partial fermentation in the large intestine (AACC, 2001). Dietary fiber can be found in many fruits, vegetables, and cereals, such as rice, wheat, corn, and sorghum. Some materials that are classified as dietary fiber are cellulose, hemicellulose, gum, pectin, and mucilage which are carbohydrate polymers, as well as materials that are not classified as carbohydrates such as lignin, waxes, and cutin. Dietary fiber also comes from food additives in the form of Arabic gum, guar gum, alginate, carrageenan, and carboxymethyl cellulose (CMC).

Dietary fiber as a function is, a food that is beneficial to health, among others, is useful

for disease prevention and health maintenance and is described as a major component in medicine and medical nutrition. Based on its solubility, dietary fiber can be grouped into two categories, namely soluble dietary fiber and insoluble dietary fiber. Pectin, gum, mucilage, and some hemicellulose are water-soluble fibers due to their ability to dissolve in hot water. This fiber can be found in many fruits, vegetables and cereals, while the gum is abundant in acacia. Cellulose, lignin, and some other hemicelluloses are insoluble in water.

About a third of total dietary fiber (Total Dietary Fiber) is soluble dietary fiber, while the largest group is insoluble fiber. Soluble fiber, especially pectin and gum, generally has the potential to increase the viscosity of intestinal contents, delay the absorption of glucose and lipids by the small intestine, affect cholesterol metabolism, and increase the production of short-chain fatty acids in the colon (large intestine). Insoluble fiber has a smaller effect on these things but tends to affect the function of the large intestine, such as stool weight, stool volume, frequency of stool excretion, and rate of transit in the digestive tract.

Consumption of viscous dietary fiber (mostly soluble fiber) lowers blood cholesterol and helps normalize insulin and blood glucose levels. The fiber portion of plant foods can be used to treat or prevent cardiovascular disease and type 2 diabetes. Many studies in Epidemiology prove the consumption of fiber-rich foods can reduce the risk of several types of cancer, namely, breast and rectal cancer. Diets that are sufficiently rich in fiber include micronutrients such as minerals, vitamins, carboxylic acid substances, phytoestrogens, and acids containing unsaturated fatty acids, which can act as healthy foods (Galisteo et al, 2008).

Dietary fiber and prevention against Cardiovascular Disease

Liu et al (2002) in their study statistically showed a reduction in heart disease. Since then, several researchers have reported, that a consistent reduction in the risk of heart disease is associated with increased dietary fiber. Article from the Women's Health Study by Liu et al. (2002) reported on the risk of cardiovascular disease associated with dietary fiber.

a.) Effects of Dietary Fiber

Adequate dietary fiber has a good effect on body health. This statement is in accordance with dietary guidelines from the Women's Health Study, although it does not recommend a specific amount of dietary fiber it does state the consumption of the number and type of foods recommended for 25 g of fiber per day. This recommendation is about twice the national standard of 14 to 15 g/day in the United States.

The median dietary fiber for the lowest quintile in the Women's Health Study was 18 g/day, and the median for the highest quintile was 26 g/day. From 10 volunteers with a very high fiber diet (55 g/1,000 kcal), it resulted in a 33% reduction in LDL cholesterol over a fortnightly period. The fiber intake level was 3.6 times the median of the highest quantile (Liu et al, 2002). Adequate fiber intake is now recommended higher, considering the many beneficial benefits for body health, adequate intake (AI) for dietary fiber as a reference for maintaining digestive tract health and other body systems' health has now been issued by the International Health Agency (Kusharto, 2006).

Dietary fiber absorbs bile acids, which will then be excreted together with feces. Bile acids emulsify fats until they break down into fatty acids that the body absorbs. In order for the fat metabolism system to not be disturbed, bile acids must be available in the digestive system.

The ability of soluble dietary fiber has been shown to have the ability to bind bile acids in both vitro and vivo studies. Where it can stimulate the excretion of sterols and indirectly reduce circulating cholesterol. Thus, it can prevent heart disease, because the number of bile acids will be reduced since they are bound by dietary fiber. This deficiency must be replaced by forming new bile acids from cholesterol in the blood, thus the concentration of cholesterol in the blood will decrease. This is very good for individuals who have too much cholesterol in their blood. Lowering cholesterol levels in the blood reduces the chances of coronary artery blockage.

Theoretical support also comes from studies conducted on ileostomy patients. The effect of two diets in the form of white bread, one rich in dietary fiber and the other low in soluble dietary fiber, then the excretion of bile acids and cholesterol was observed. A high-fiber diet significantly increased sterol excretion and was followed by a decrease in LDL cholesterol. Furthermore "cholestyramine" which is usually used for the treatment of hypercholesterolemia works on this principle and has been shown to reduce coronary heart disease. Dietary fiber in the colon will ferment to produce SCFA (short chain fatty acids), including acetate, propionate, and butyrate which are reported to prevent the increase in cholesterol (propionate) or prevent colon cancer (butyrate). The high water-binding capacity of dietary fiber can result in bulk digestion (intestinal contents) and high-water content, thereby preventing constipation and diverticulosis. The ability to bind organic molecules can result in the binding of bile and ultimately can lower cholesterol (Marsono, 2008).

b.) Mechanism of Dietary Fiber Reducing Cardiovascular Disease

Coronary Heart Disease (CHD) is a cardiovascular disorder. The main cause of coronary heart disease (CHD) is hyperlipidemia

or hyperproteinemia, which is the result of impaired transport of lipids or body fat. CHD begins with the occurrence of atherosclerosis, which is a disease condition caused by a blockage due to the thickening and hardening of the inner artery walls. Atherosclerosis is a combination of various physical, biological, and chemical processes that are very complex, both in terms of the sequence of events and their cellular interactions.

There are several types of lipids in the blood, but the most common ones are cholesterol and triglycerides. Lipids are important for the functioning of cells and are used as energy, protecting important organs, forming cells, synthesizing various hormones and others. But if lipid levels exceed the limit, namely in a state of hyperlipidemia, illnesses will arise, including coronary heart disease. Lipids are insoluble in water, therefore require special transporters to be able to flow with blood serum throughout the body. Lipids will be bound to proteins so that they are soluble and can be transported from one place to another in the body. These bonds are called lipoproteins.

Several types of lipoproteins are LDL (Low-Density Lipoprotein), HDL (High-Density lipoprotein), VLDL (Very Low-density lipoprotein), and chylomicrons. Low-Density Lipoprotein (LDL) functions to circulate cholesterol to tissue cells. The higher the LDL level, the more cholesterol deposits in the walls of blood vessels, therefore the possibility of atherosclerosis is greater. LDL cholesterol is also known as bad cholesterol. On the other hand, HDL lipoprotein, classified as good cholesterol, is responsible for transporting cholesterol from tissues and blood vessel walls to the liver for metabolism.

Dietary fiber is often distinguished based on its solubility in water, namely soluble dietary fiber and insoluble dietary fiber. Soluble fiber is a dietary fiber that can be dissolved in cold, warm, or hot water and can be precipitated in an ethanol solution. This dietary fiber absorbs water as it passes through the digestive tract and is fermented by bifidobacterial in the large intestine to produce short-chain fatty acids, such as acetic, propionic, and butyric acids in a process known as anti-constipating. These fatty acids then play a role in maintaining the pH of

the intestine and remain acidic in accordance with the pH of beneficial bacteria, as well as pH conditions that are not desired by harmful bacteria. Examples of soluble fiber are pectin in fruits, glucans in cereals, and gums in nuts, seeds, and seaweed (Dwiyitno, 2011).

Water-soluble dietary fiber components such as pectin, gum, and hemicellulose have an effect on reducing cholesterol levels and controlling blood sugar levels. Patients with hypertriglyceridemia (excess triglycerides, a type of lipid) who consume foods rich in complex carbohydrates (crude fiber) from dried legumes (beans) can reduce triglycerides and total serum LDL-cholesterol. This is because the presence of crude fiber as an antioxidant compound causes carbohydrates to be digested slowly, thereby controlling the effect of hyperlipidemia. Dietary fiber given to adult men and women aged 50-79 years can prevent the risk of coronary heart disease. Dietary fiber is able to bind bile acids (the end product of cholesterol), thereby preventing its reabsorption from the intestine. In addition, it can also increase its excretion through feces, so that it will increase the conversion of blood serum cholesterol into bile acids, as a result, it can reduce blood cholesterol levels.

The end products of fat digestion in the small intestine are monoglycerides, fatty acids, cholesterol, phospholipids, and short and medium-chain triglycerides. In the lumen of the small intestine, these compounds combine with bile to form aggregates called micelles. Lignin and pectin as constituents of dietary fiber have cation exchange groups that are able to bind bile acids and function as emulsifiers. Cholesterol that is bound to bile acids and lignin/pectin cannot be absorbed by the intestines but will be excreted in the feces. In addition to dietary fiber, prevention of cardiovascular disease can be done with a low-fat diet. A low-fat diet (30% of total calories) is still considered by many doctors to be a healthy option. for both primary and secondary prevention of cardiovascular disease (CVD). reduced HDL lipoprotein and increased triglycerides (Giugliano et al, 2006).

Furthermore, according to Giugliano et al (2006), three strategies that can help prevent Congenital Heart Disease (CHD) are: 1) increasing consumption of omega-3 fatty acids

from fish or plant sources; 2) replacing saturated fat and trans-fats with non-hydrogenated unsaturated fats and 3) high diet with fruits, vegetables, nuts, and cereals. The effects of diet on CHD may be mediated through a variety of biological pathways other than serum lipids, including oxidative stress, inflammation, endothelial dysfunction, insulin sensitivity, blood pressure, and thrombotic tendencies.

Conclusion

Seaweed is a water-soluble fiber. The soluble fiber in water has an effect on reducing cholesterol levels and controlling blood sugar levels. The ability of soluble dietary fiber has been shown to be able to bind bile acids well and can stimulate the secretion of sterols and can indirectly reduce circulating cholesterol. Followed by a decrease in total and LDL cholesterol. LDL circulates cholesterol in tissue cells. The higher the LDL level, the more cholesterol deposits in the walls of blood vessels, so the possibility of atherosclerosis is greater.

Cholesterol that is bound to bile acids and lignin/pectin cannot be absorbed by the intestines but will be excreted in the feces. The number of bile acids will be reduced because it is bound by dietary fiber. This deficiency must be replaced by forming new bile acids from cholesterol in the blood. Thus, the concentration of cholesterol in the blood will decrease. This is excellent for individuals who have high cholesterol levels in their blood. Lowering cholesterol levels in the blood reduces the chances of coronary artery blockage.

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