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The effects of seaweed oligosaccharides on humanity

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Abstract. Seaweed oligosaccharides are complex carbohydrates derived from various types of seaweed. They are widely studied due to their numerous potential health benefits for humans. There are several reasons why studying seaweed oligosaccharides is important. Firstly, seaweed is a renewable and sustainable resource, and it can be harvested without damaging the environment. Additionally, seaweed contains high health value and high levels of minerals, vitamins, and other bioactive compounds, which makes it a valuable source of nutrition. They can also help to modulate the immune system, improve gut health, and lower cholesterol levels. Research suggests that seaweed oligosaccharides may have therapeutic potential in the treatment of various diseases, such as diabetes, obesity, and cancer. They have also been discovered to have a number of applications in the food, cosmetic, and pharmaceutical industries. In conclusion, studying seaweed oligosaccharides is important because they offer numerous potential health benefits for humans and have a wide range of applications in various industries.

Keywords: seaweed oligosaccharides, sustainable resource, immune system, health value, potential applications.

1. Introduction

Seaweed oligosaccharides are oligosaccharides extracted from seaweed, composed of monosaccharide molecules such as glucose, galactose, and glucuronic acid [1]. It is a natural polysaccharide that is widely found in various seaweeds. Seaweed oligosaccharides have a variety of physiological functions and application values due to their structure, solubility and biological activity.

Seaweed oligosaccharides are mainly composed of three monosaccharides: glucose, galactose and glucuronic acid. From the composition of monosaccharides, seaweed oligosaccharides can be divided into different types, including laminar oligosaccharides, kelp oligosaccharides, wakame oligosaccharides [2]. The regulation of intestinal flora is its most important role, because the balance of intestinal flora is crucial to human health. Seaweed oligosaccharides, as a prebiotic, can promote the growth and activity of beneficial bacteria in the intestine, inhibit the growth of harmful bacteria, maintain the balance of intestinal microecology, and promote intestinal health. Seaweed oligosaccharides are widely used in food, health products, medicine, cosmetics and other fields [3]. In food and health care products, seaweed oligosaccharides can be used as additives to enhance their nutritional value and health effects; in the field of medicine, seaweed oligosaccharides can be used as antibacterial drugs, regulate intestinal flora, etc.; As a moisturizer, anti-wrinkle agent, etc.

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The significance of studying seaweed oligosaccharides lies in:

1. Discover natural intestinal health agents: Seaweed oligosaccharides are natural polysaccharides that can be used as a natural intestinal health agent. research hotspots [4].

2. Explore the biological activity of seaweed oligosaccharides: seaweed oligosaccharides have a lot of biological activities, which can have a variety of beneficial effects on human health [5]. Through the in-depth study of the biological activity of seaweed oligosaccharides, we can explore its mechanism of action in the human body and provide a more reliable theoretical basis for its application.

3. Find new medicines and food additives: Seaweed oligosaccharides have various biological activities and are expected to be used in the fields of medicine and food additives, such as antibacterial drugs and health products that regulate intestinal flora. Edible seaweed oligosaccharides like Figure 1. Therefore, the research on seaweed oligosaccharides can not only provide new health care solutions for intestinal health, but also develop new medicines and food additives to promote the development of related industries.

Figure 1. Edible seaweed oligosaccharides are made up of short chains of sugar molecules that are resistant to digestion in the small intestine. As a result, they pass into the large intestine, where they act as prebiotics, promoting the growth of beneficial gut bacteria. This can help improve digestive health and reduce the risk of certain diseases.

(From https://m.chemicalbook.com/SupplyInfo_358579.htm.)

2. Distribution of seaweed oligosaccharides

Seaweed oligosaccharides can be found in various types of seaweed, including brown seaweed (such as wakame, kombu, and hijiki), red seaweed (such as dulse and nori), and green seaweed (such as sea lettuce) [6]. The distribution of seaweed oligosaccharides in these different types of seaweed can vary.

For example, fucoidan is a type of seaweed oligosaccharide which is in brown seaweed, while carrageenan is a type of seaweed oligosaccharide that is primarily found in red seaweed. Green seaweed may contain different types of oligosaccharides, such as ulvan. The amount of seaweed oligosaccharides in seaweed can also vary depending upon factors such as the season, and the location where it was harvested [7]. In general, brown seaweed tends to have higher levels of oligosaccharides than red or green seaweed.

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Overall, seaweed oligosaccharides are distributed widely throughout different types of seaweed, and the specific distribution can vary depending on the type of oligosaccharide and the seaweed species.

3. Preparation of s seaweed oligosaccharides

Seaweed oligosaccharides can be prepared through different methods depending on the specific type of oligosaccharide needed. As shown in Figure 2, this is an artificially prepared fucoidan oligosaccharide. However, the following is a general method for preparation:

1.Harvest or purchase fresh seaweed, preferably from an unpolluted source.

2.Wash the seaweed thoroughly with fresh water to remove any impurities.

3.Cut the seaweed into small pieces and dry it using a low-temperature oven or a food dehydrator.

4.Grind the dried seaweed into a fine powder using a blender or a food processor.

5.Extract the oligosaccharides from the seaweed powder using one of the following methods [8]:

Enzymatic hydrolysis: Add an enzyme, such as cellulase or pectinase, to the seaweed powder and incubate it at an appropriate temperature and pH to break down the complex polysaccharides into oligosaccharides. Then, filter the mixture to separate the oligosaccharides from the residue.

Acid hydrolysis: Add an acid, such as hydrochloric acid or sulfuric acid, to the seaweed powder and heat it at an appropriate temperature to break down the polysaccharides into oligosaccharides. Then, neutralize the mixture with a base, such as sodium hydroxide, to stop the acid hydrolysis reaction. Finally, filter the mixture to separate the oligosaccharides from the residue.

Ultrasonic extraction: Add the seaweed powder to a solvent, such as water or ethanol, and sonicate the mixture at an appropriate frequency and amplitude to extract the oligosaccharides. Then, filter the mixture to separate the oligosaccharides from the residue [9].

Purify the oligosaccharides by removing any impurities using techniques such as ion exchange chromatography, size exclusion chromatography, or membrane filtration.

The specific conditions and equipment needed for each step may vary depending on the type of seaweed and oligosaccharide being prepared. It is important to carefully follow established protocols and safety precautions to ensure the quality and purity of the final product.

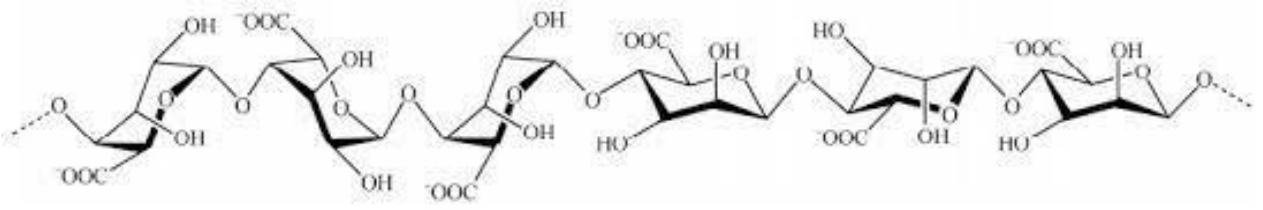

Figure 2. It’s a common functional seaweed oligosaccharides. It is prepared by hydrolyzing alginate with hydrochloric acid, oxalic acid, formic acid and sulfuric acid.
(From https://seaweedextractfertilizer.com/2021/03/16/alginate-oligosaccharides-for-agriculture/.)

4. Function of seaweed oligosaccharides

Seaweed oligosaccharides are a type of polysaccharides extracted from seaweed, which have various biological activities and medical applications. Some of the known functions of seaweed oligosaccharides include:

Immunomodulatory effect: Seaweed oligosaccharides can enhance the body's immunity, promote the activity of macrophages, and increase the activity of T cells, thereby improving the body's resistance to various diseases [10].

Antioxidant effect: Seaweed oligosaccharides can scavenge free radicals, reduce oxidative stress on the body, and help prevent various diseases.

Intestinal health effect: Seaweed oligosaccharides can promote the growth of probiotics, improve the balance of intestinal flora, and enhance intestinal health [11].

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It should be noted that the functions of seaweed oligosaccharides are still being studied and explored in many aspects, and the above-mentioned functions are just some of the known ones.

The function of seaweed oligosaccharides in antibacterial:

Seaweed oligosaccharides are complex carbohydrates that are derived from seaweed. They have been found to have various biological activities, including antibacterial properties.

The antibacterial activity of seaweed oligosaccharides is believed to be due to their ability to interfere with bacterial cell wall synthesis and to disrupt bacterial biofilms. They can also stimulate the immune system, which can help to fight off bacterial infections.

Overall, seaweed oligosaccharides have a promising potential as a natural antibacterial agent, and further research is needed to fully understand their mechanisms of action and potential applications in healthcare and food industry.

The function of seaweed oligosaccharides in Immunomodulatory:

Seaweed oligosaccharides are complex carbohydrates that are extracted from different species of seaweeds. They have been shown to have a range of biological activities, including immunomodulatory effects. Immunomodulation refers to the ability of a substance to regulate the immune system, either by enhancing or suppressing its activity [12].

Studies have shown that seaweed oligosaccharides can modulate various aspects of the immune system. For example, they can stimulate the production of cytokines, which are signaling molecules that regulate immune responses. Seaweed oligosaccharides can also enhance the activity of natural killer (NK) cells.

Furthermore, seaweed oligosaccharides can modulate the activity of immune cells, which are related in adaptive immunity. They can also promote the production of immunoglobulins, which are antibodies that help the body to fight off infections.

Overall, seaweed oligosaccharides have shown promise as potential immunomodulators.

The function of seaweed oligosaccharides in Lipid-lowering:

Seaweed oligosaccharides are complex polysaccharides extracted from seaweed. They have been shown to have various health benefits, including lipid-lowering properties.

One of the ways in which seaweed oligosaccharides can lower lipid levels is by reducing the absorption of cholesterol in the gut. Seaweed oligosaccharides can bind to bile acids in the intestines, which are made from cholesterol, and excrete them from the body. This process can increase the demand for cholesterol in the liver, which can lead to a decrease in circulating levels of cholesterol in the blood.

Seaweed oligosaccharides can also stimulate the liver to produce more bile acids, which can further aid in the excretion of cholesterol. Additionally, seaweed oligosaccharides can inhibit the activity of enzymes involved in the synthesis of cholesterol in the liver, which can reduce the production of cholesterol.

Furthermore, seaweed oligosaccharides can also modulate the gut microbiota, which plays a critical role in the metabolism of lipids. Seaweed oligosaccharides can increase the abundance of beneficial bacteria that are involved in the breakdown of lipids and decrease the levels of harmful bacteria that can contribute to lipid metabolism disorders [13].

Overall, seaweed oligosaccharides can help lower lipid levels through multiple mechanisms, including reducing cholesterol absorption, increasing cholesterol excretion, inhibiting cholesterol synthesis, and modulating the gut microbiota.

The function of seaweed oligosaccharides in Antioxidant:

Seaweed oligosaccharides are complex carbohydrates that are derived from various species of seaweed. These oligosaccharides have been shown to possess antioxidant properties, which means that they are capable of neutralizing harmful free radicals in the body.

Free radicals are unstable molecules that are produced naturally by the body as a result of metabolism or exposure to environmental factors such as pollution, radiation, and UV rays.

In addition to their antioxidant properties, seaweed oligosaccharides have been shown to possess other health benefits, such as anti-inflammatory and immunomodulatory effects. They have also been

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found to exhibit prebiotic activity, promoting the growth of beneficial gut bacteria and improving digestive health.

Overall, seaweed oligosaccharides are a promising natural antioxidant source that may offer numerous health benefits. The function of seaweed oligosaccharides in intestinal health:

Seaweed oligosaccharides are complex carbohydrates that are extracted from seaweed. They have been found to have various health benefits, including improving intestinal health.

Studies have shown that seaweed oligosaccharides can promote the growth of beneficial bacteria in the gut, such as Bifidobacterium and Lactobacillus, while inhibiting the growth of harmful bacteria. This is due to their prebiotic properties, which means that they act as food for beneficial bacteria, allowing them to flourish and produce beneficial byproducts.

Furthermore, seaweed oligosaccharides have been found to enhance the intestinal barrier function by strengthening the mucosal layer, which helps prevent harmful substances from entering the bloodstream. They also help regulate the immune response in the gut, which can help reduce inflammation and prevent intestinal diseases.

Figure 3. This is an agricultural type seaweed oligosaccharide. Algal oligosaccharides have the effect of promoting plant growth and can be used for the remediation of heavy metal pollution of plants. (From https://seaweedextractfertilizer.com/2021/03/16/alginate-oligosaccharides-for-agriculture/.)

5. Discussion

Seaweed oligosaccharides are complex carbohydrates that have a number of potential applications in various industries. Here are some more details about their potential value and future research directions:

Food industry: Seaweed oligosaccharides can be used as functional ingredients due to their nutritional properties, including their high fiber content and prebiotic effects. Prebiotics are substances that feed the beneficial bacteria in our gut, promoting good digestive health. Additionally, seaweed oligosaccharides have been shown to have potential as natural food preservatives, reducing the growth of bacteria and fungi in food products [14].

Pharmaceutical industry: Seaweed oligosaccharides have been studied for their potential therapeutic properties, including anticoagulant, antiviral, immunomodulatory, and anticancer effects. For example, some studies have shown that seaweed oligosaccharides can inhibit the growth of cancer cells, induce apoptosis (programmed cell death), and enhance the immune response to cancer cells.

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Other studies have found that seaweed oligosaccharides can inhibit blood clotting and potentially prevent thrombosis.

Cosmetic industry: Seaweed oligosaccharides are increasingly being used in skincare and hair care products due to their moisturizing, anti-aging, and strengthening properties. For example, some studies have shown that seaweed oligosaccharides can improve skin hydration, reduce the appearance of wrinkles, and increase collagen production. In hair care products, seaweed oligosaccharides can strengthen hair strands and increase elasticity, reducing breakage and promoting healthy hair growth.

Agriculture and environmental remediation: Seaweed oligosaccharides have potential applications in agriculture as plant growth regulators, improving crop yields and enhancing plant resistance to pests and diseases. Such as the product in Figure 3 is shown. They can also be used in environmental remediation to reduce heavy metal pollution in soil and water.

Future research directions for seaweed oligosaccharides may include:

Further studies on their biological activities and mechanisms of action in various applications, including food, pharmaceuticals, cosmetics, and agriculture. Exploration of new extraction and purification methods to improve the yield and quality of seaweed oligosaccharides. Investigations into the safety and toxicity of seaweed oligosaccharides, particularly for long-term use and at high doses. Development of new products and formulations that incorporate seaweed oligosaccharides for various applications. Studies on the sustainability of seaweed farming and harvesting practices, to ensure that these resources are used responsibly and without negative environmental impacts.

However, there are some limitations associated with the use of seaweed oligosaccharides:

Availability: The availability of seaweed oligosaccharides is limited by the availability and sustainability of seaweed resources. The production of seaweed oligosaccharides can also be costly and time-consuming [15].

Variability: The composition of seaweed oligosaccharides can vary depending on the species of seaweed, the season, and the location of harvest. This variability can affect their functionality and consistency in different applications.

Regulatory status: Seaweed oligosaccharides are not yet approved as a food additive in some countries, which may limit their use in food and beverage products.

Allergenicity: Seaweed oligosaccharides can potentially cause allergic reactions in individuals with a sensitivity to seafood or iodine.

Overall, while seaweed oligosaccharides have potential health benefits, their use may be limited by these factors, and further research is needed to fully understand their safety and effectiveness.

6. Conclusion

Algae oligosaccharides are short chains of carbohydrates derived from various species of algae. They have several potential functions in various fields, including nutrition, medicine, and biotechnology. In the food industry, algae oligosaccharides are used as prebiotics, which help promote the growth of beneficial bacteria in the gut. They are also used as thickeners, stabilizers, and emulsifiers in various food products. In medicine, algae oligosaccharides have shown promising results in the treatment and prevention of various diseases such as cancer, diabetes, and cardiovascular diseases. They have also been found to have immunomodulatory effects, meaning they can help regulate the immune system and potentially reduce inflammation. In biotechnology, algae oligosaccharides have potential applications as biofuels and in the production of pharmaceuticals, cosmetics, and other products. Overall, algae oligosaccharides have a number of potential functions, and ongoing research is exploring their full potential in various fields. As research continues, it is likely that more uses and applications for algae oligosaccharides will be discovered.

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