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# Progress in the Immunomodulatory Effects of Marine Bioextracts

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## Abstract

As natural immunomodulators, Marine biological extracts can identify, block and eliminate harmful bacteria and maintain the stability of the overall environment in the body. By analyzing the immunemodulatory effect of Marine organisms, this paper explores the research progress of Marine bioactive substances, and provides the basic preparation for the extraction of multiple immunomodulatory substances.

## Keywords

Marine biological extracts; Immune regulation; Research progress

## Introduction

Oceans cover more than 70% of the Earth's surface, and seawater accounts for approximately 90% of the Earth's total water volume. The ocean is a treasure trove of biological resources, boasting not only a rich diversity of species but also a complex classification system. Marine organisms possess unique structures and functions to sustain their life activities. Due to the special nature of the marine environment and the role of marine microorganisms in the ecosystem chain, there is an urgent desire to find new and effective drugs from marine microorganisms to meet human needs.

## 1. Research Progress on the Immunomodulatory Effects of Marine Biological Extracts

### 1.1 Classification of Immune Regulation

The number of people who die from cancer each year is approximately 6.5 million, and there is one cancer patient in every 200 families. At present, people have been using marine natural products for clinical research. Anti-cancer active substances found in the ocean act on microtubules and maintain the stability of biological active structures. Anti-cancer active substances that interfere with DNA synthesis or repair, and anti-cancer active substances that act on lysosomes. Active substances that enhance human immunity, a large number of active natural ingredients found in marine organisms, can be used to the maximum extent possible in the development of new drugs. From them, we can find new biological species, extract and separate active compounds, find defensive substances, and trace their biological sources. Natural drugs have a strong advantage over chemically synthesized drugs and have huge drug market potential. The vast ocean contains a variety of substances with anti-tumor active ingredients. In essence, they are not only more complex in structure, but also more diverse in type. These marine biological extracts have a strong regulatory value and effect on immunity to a great extent. Under normal circumstances, immune organs, immune cells and immune active substances form the immune system [1]. From another perspective, immunity can be divided into two different types: non-specific immunity and specific immunity. Normally, the autoimmune system automatically helps prevent the invasion of foreign substances, achieving the main purpose of eliminating pathogens and


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providing a stable environment for the body, thus fulfilling its primary protective function. Once the body's structure is damaged, it can not only cause damage to reproductive organs but also lead to more serious malignant tumors or cancer. Autoimmune diseases are among the most common immune diseases, and their development requires comprehensive research and analysis. Overactive immune function leading to autoimmune diseases can also cause other defects and even increase the body's susceptibility to infection, making treatment more difficult.

## 1.2 Marine organisms with immunomodulatory functions

### 1.2.1 Marine microorganisms

Marine organisms in the special environment of the ocean, marine microbial active ingredients mainly include polysaccharides, proteins, lipids and terpenes. More and more compounds with anti-tumor and antibacterial activities are being developed from traditional Chinese medicine, marine drugs, etc., but the research efforts are insufficient and the clinical value is very small in actual application. Through the study of the interaction between natural drugs and cells, not only can the mechanism of drug action be explored, but also new drugs can be screened according to the actual situation. Under normal circumstances, marine microorganisms live in special environments such as high temperature resistance, low temperature resistance, alkali lovage, anaerobic, and no need for light. When implementing them, there are certain difficulties, which have strong research value. In the process of practice, marine microorganisms have the functions of immune regulation and anti-tumor. At the same time, they also have the value of anti-oxidation, anti-inflammatory and anti-cancer. These biological activities are extracted from marine microorganisms and can prevent many infectious diseases to a large extent. For example, Pang Huanying et al. extracted the protein TolB from the marine microorganism Vibrio alginolyticus HY9901 [2]. Experiments with extracted active substances in mice and grouper revealed a significant change in serum antibody titers detected by ELISA. Simultaneously, recombination with proteins resulted in other reactions. UMEZAWA et al. discovered the extracellular polysaccharide Marinettalan in Flavobacterium humifusa. These active substances can enhance humoral immunity, achieving the primary goal of inhibiting sarcomas. They promote tumor cell metastasis, minimize the further formation of solid tumors and ascites, and provide a good foundation for subsequent development. In terms of immune activity, they not only participate in the regulation of autoimmune diseases but can also be widely cultivated in specific environments to increase the immunity of cancer patients, making a significant contribution to medicine.

### 1.2.2 Marine algae

Because the bioactive components in natural medicines are highly complex, during development and research, it is crucial to clarify the nature and laws of the activities of various cellular life forms, and to determine whether all changes involve all cellular life processes. In the current course of social development, the public's demand for diet is gradually increasing, moving towards health and green practices. Marine organisms are generally rich in polysaccharides and proteins, playing a key role and value in improving public health. For example, they can enhance immunity, prevent diabetes, and lower blood lipids. Bian Jun et al. extracted polysaccharides from *Ulva pertusa *, further transforming mouse spleen lymphocytes into other functional groups. At this time, the number of lysosomes decreased, while CD80, CD83, CD86, CD40, and IL-12 showed an increasing trend, which can induce BMDC maturation. LV, et al., focusing on *Ulva pertusa*, aim to achieve the migration of active substances and maintain anti-tumor activity under reasonable overall planning. Lin Changzheng et al. developed an active substance that induces T cell proliferation and enhances immunity based on the fractionated products PSS1, PSS2, PSS3, and PSS4.

### 1.2.3 Marine shellfish

At present, the number of marine organisms studied by humans has reached more than 3,000. The discovery of marine natural active ingredients often has a complex chemical structure, low content, and its own implementation method when determining the structure. Finding economical, artificial, and environmentally friendly drug sources has become the focus of current research. Modern aquaculture methods can give marine shellfish more development prospects and show different immune regulation effects and values. Zhang Caimei et al. conducted a reasonable analysis of non-specific immune function based on scallop polypeptides, so that the killing activity of mouse NK cells can be improved according to the inhibition model. Wang Jun et al. extracted more MPs-Bl mussel polysaccharide from thick-shelled mussel Mytilus coruscus, which not only has high purity, but also enhances the killing ability of NK cells. Zheng Minggang et al. proved the immune factors of higher animals based on wrinkled abalone Haliotis discus hannai and explored different homologous series [3]. Liu Jingjing et al. constructed an alcoholic liver injury model by using ethanol, reduced the expression of IL-2 and CD4+, and reflected the immune factors similar to those of higher animals. Huang Yanjun and others, mainly in Scapharca In subcrenata polypeptide extract, PEAS was found to promote lymphocyte proliferation. The polypeptides can be digested enzymatically, preserving their original natural activity and expanding the development of marine drugs.

### 1.2.4 Marine fish

Due to the inherent characteristics of marine organisms—their significant biological activity—while some of this activity can be synthesized artificially, most requires the proper use of techniques and methods. Whether in coastal or deep sea areas, the diverse life patterns of various fish can be observed directly. From different perspectives, this can enhance immunity and improve the treatment of endemic cancers, showcasing the natural medicinal resources of the ocean. In different immune genes, reducing external interference and improving immune capacity can be achieved through diverse indicators to effectively demonstrate the transcriptional levels of immune response genes. LI et al. identified that *Syngonium semismoothienos* enhanced the cells' ability to resist bacterial infection through real-time quantitative PT-PCR detection. Shen Xianrong et al. found that a concentration of 0.087 g/kg of *Syngonium spp.* extract maximized the killing activity of NK cells and improved immune response, providing effective scientific data for subsequent research.

### 1.2.5 Marine crustaceans

Bacteria are diverse and pose a threat to human health to some extent. Marine organisms contain a wide variety of compounds with unique compositions, exhibiting strong advantages in the interaction between natural drug molecules and biological macromolecules. Chromatography-mass spectrometry (GC-MS) has demonstrated significant application value, enabling the rational study of active ingredients in water-soluble extracts of marine organisms and stimulating cell-cell interactions. However, finding new biological species and discovering new active lead structures is becoming increasingly difficult. Shrimp and crabs constitute a large population in the ocean, possessing not only relatively tender flesh but also abundant amounts of elements such as calcium, iron, potassium, magnesium, and phosphorus. Chitosan and deacetylated aminopolysaccharides in these organisms can effectively enhance immunity and minimize the elimination of harmful factors. Xiao Yanyi et al. used chitosan to rationally increase the activity of acid phosphatase in Russian sturgeon. Shi Mingjian et al. transformed lymphocytes, activated macrophages and basophils, and regulated their adaptation to achieve the main purpose of non-specific immune enhancement. DYKEN et al. stimulated innate lymphocyte type 2 cells within the chitin-induced epithelial cell content. They observed different concentrations of COS to demonstrate the immunomodulatory effects of COS and NAG. Tang Jun et al. proposed incorporating chitosan oligosaccharides into the diet during late pregnancy, which also reduced the impact on IL-2 and complement C3 proteins. From a holistic perspective, chitosan oligosaccharides can enhance the immune capacity against specific pathogens in late pregnancy sows and piglets, increasing the corresponding concentration and improving anti-tumor effects.

### 1.2.6 Marine mammals

Some peptides and proteins found in marine organisms possess strong anti-tumor activities, exhibiting diverse developmental patterns based on protein molecular weight and polarity. Measuring the effects of active ingredients in marine natural products on bacterial and tumor cell activity allows for the determination of the pass rates of extracts in bacteria and tumor cells, maximizing the development of new anti-cancer drugs. Seal meat and seal oil contain abundant $\omega$-3 unsaturated fatty acids, squalene, and other valuable substances that can effectively enhance health. Many of the seven essential amino acids are recognized as immune enhancers. DE SWART et al. addressed this issue by rationally comparing the effects of herring feeding on spotted seals, analyzing marine areas with varying degrees of pollution. The main purpose of this was not only to reduce disease infection rates but also to enhance immune function. Liver cirrhosis and chronic hepatitis, in practice, can lead to immune system disorders. Guo Yu et al., based on the protective and immunomodulatory effects of shark peptides on immune-induced liver injury in mice, further enhanced the rational inhibition of TNF-$\beta$ expression. Not only to induce PBMC secretion, but also to enhance TNF-$\beta$ expression [4].

### 1.2.7 Other marine invertebrates

In recent years, the emerging marine ecological research has sought to find defensive substances, providing a new development path for marine natural drugs. The application of these technologies has fundamentally broken through the limitations of marine resources, opening up new directions for marine drug research to the greatest extent possible.

Sea cucumbers, starfish, sponges, and sea urchins all have significant relationships with immunologically active substances. Wei Zhengman et al., based on sea squirts, discovered HQSV, which can not only address the problem of low immunity but also achieve a major role in immunomodulation. Essentially, low and medium doses of HQSV can enhance phagocytic function and ensure the proliferation and differentiation of splenic T lymphocytes. Zhang Min et al., based on the sea urchin *Echinochloa glabripennis*, discovered sea urchin yellow polysaccharide SEP-S, with a purity reaching 97.6%. Yang Yang et al. conducted experiments on mice to analyze the effects of sea cucumber polysaccharides on mouse immune function. Zhang Lixin et al. mainly conducted preliminary extraction based on 21 species of marine invertebrates, showing immunosuppressive and synergistic stimulatory effects. Lei Min et al., under the perspective of hydrogenation, rationally analyzed the phagocytic capacity of macrophages based on the killing activity of NK cells, maintaining a gradually increasing value. They comprehensively utilized genetic engineering to express certain functional genes of marine organisms, and maximized the acquisition of active substances by constructing DNA or genome libraries. Marine biological extracts can inhibit oxidative stress and repair damaged DNA. They directly absorb photons, achieving the main effects of immune regulation and inflammation suppression. They reduce light damage, resist oxidative stress, promote damage repair, regulate immune abnormalities and inflammatory responses, delay collagen loss, promote biological synthesis, enhance skin hydration, and ensure skin radiance.

## 2. Conclusion

With societal progress, marine biological extracts, due to their "natural and healthy" characteristics, are not only more readily accepted by the public but also offer greater potential for exploring the ocean's treasures and showcasing a wide range of applications. Marine biological products are generally mild, widely available, and have few toxic side effects; however, their extraction processes are complex, making large-scale production difficult. Therefore, the development of marine biological extracts must be based on natural ingredients, rationally optimized, and implemented in a modern production process. Through interactions with cells, the activity of natural products can be inferred, leading to the development of novel drugs and maximizing the exploration of drug mechanisms of action.

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