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Analysis of Bioactive Components of Oyster Protein Peptide and its Application in Health Food

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Abstract. Oyster protein peptides (OPPs) have attracted a great deal of interest due to their potential health benefits and therapeutic effects. Recent studies have highlighted the rich material composition of OPPs. However, there are still gaps in the understanding of the comprehensive physiological functions and bioavailability of these bioactive substances. In this research, the bioactive components and physiological functions of OPPs were analyzed. The essential amino acids in OPPs support muscle health, energy production, and blood sugar regulation, while glutathione and taurine provide potent antioxidant effects and manage oxidative stress. Zinc enhances immune function and skin integrity and polysaccharides enhance immune cell activity, and vitamins B1, A, and D are essential for DNA synthesis, brain function, and bone health. These findings highlight the potential of OPPs as a valuable ingredient for developing healthy foods. The significance of this research is to promote the development of functional food and nutrition and health care, and promote the sustainable development of oyster farming and processing industry. Future research should focus on clinical trials to determine the therapeutic potential and safety of OPPs, explore the molecular mechanisms behind its bioactive effects, and develop standardized extraction methods to ensure consistency and potency. This research provides a reference for future research and highlights areas that require further investigation, such as the bioavailability of OPPs and the long-term effects on human health.

Keywords: Oyster protein peptides; bioactive components; applications.

1. Introduction

Oysters, prized for their culinary and nutritional values, have been consumed for centuries and are well known for their rich protein content. Recently, there has been a growing interest in exploring the bioactive components derived from oyster protein peptides (OPPs) due to their potential health benefits [1]. These peptides are short chains of amino acids that are produced through enzymatic hydrolysis of oyster proteins. The unique amino acid composition and sequence of OPPs endow them with various bioactivities, including antioxidant, antihypertensive, antimicrobial, and immunomodulatory effects [2]. These properties make OPPs a promising candidate for the development of functional foods and nutraceuticals aimed at promoting health and preventing diseases.

Several studies have investigated the extraction, characterization, and health benefits of bioactive peptides from oysters. For instance, researchers demonstrated that peptides derived from oyster hydrolysates exhibit significant antioxidant activities, which can help in mitigating oxidative stress-related disorders. Similarly, a study by Gomez found that specific peptides from oyster protein hydrolysates have potent antihypertensive effects, making them useful in managing high blood pressure.

Additionally, OPPs have shown promise in modulating immune responses. A study by Hao indicated that these peptides can enhance the proliferation and activity of immune cells, thereby boosting the body's defense mechanisms. The growing body of evidence supporting the health benefits of OPPs has spurred further research into their mechanisms of action and potential applications in health food products.

The investigation of bioactive elements found in natural sources has drawn a lot of interest because of their possible medicinal and health advantages. One of the sources is OPPs, which provide a wealth of bioactive compounds with a variety of physiological roles [3]. With the increasing demand for natural ingredients that promote health, OPPs have become a viable option for creating innovative functional meals and dietary supplements.

Simultaneously, there are major global health issues due to the prevalence of chronic diseases like infections, diabetes, and hypertension. The search for alternative therapeutic possibilities is prompted by the limits associated with conventional treatments. Comprehending the bioactive characteristics of OPPs offers a chance to tackle these issues by utilizing their anti-inflammatory, antioxidant, and immunomodulatory impacts [4].

The goal of this research is to investigate the characterisation and extraction of OPPs and their various uses in functional meals and dietary supplements. The aim is to close the gap between scientific knowledge and practical use by methodically examining their bioactive components and potential health benefits. In addition, the incorporation of OPPs into food items has the potential to advance sustainability in the maritime sector and raise the value of marine resources [5].

Taking these factors into account, this research aims to address urgent health issues while advancing the functional food business. Moreover, the objective is to promote sustainable food production methods and enhance public health outcomes, ultimately leading to a more robust and resilient community.

2. Bioactive Substances and Functions of OPPs

OPPs, which are derived from the hydrolysis of oyster protein, have recently gained interest in food science due to their potential health benefits and therapeutic effects. These peptides are rich in a variety of bioactive substances, including essential amino acids, glutathione, taurine, zinc, polysaccharides, and many vitamins and minerals. This section aims to comprehensively analyze the bioactive substances present in oyster protein peptides and their various physiological functions.

2.1. Essential Amino Acids

OPPs contain a variety of essential amino acids, such as leucine, isoleucine, and valine, which are essential for tissue repair, muscle growth, and enzyme production [6]. These proteins are essential amino acids, and they must be obtained through the diet. These amino acids are found in oyster peptides, which promote muscle protein synthesis, improve body function, and support good metabolic health.

1) Nourish muscles: Amino acids can provide nutrients needed by muscles, participate in protein synthesis, promote growth and development, increase muscle weight and other effects, which is very important for muscle health.

2) Improve the normal function of the body: Amino acids can also participate in cell metabolism, support the immune system, regulate the nervous system and other physiological functions to maintain the normal function of the body.

3) Energy production: Some amino acids can be broken down in the body's metabolic process to produce energy.

4) Regulation of blood sugar: Certain amino acids, such as glutamic acid and alanine, can be converted into glucose or participate in the regulation process of blood sugar stability.

2.2. Glutathione

Glutathione is an important component of OPPs, which can significantly improve its antioxidant properties. It is a tripeptide including glutamine, cysteine and glycine, which is an important part of

the body's defense system against oxidative stress [7]. Its chemical structure, shown in Figure 1, is characterized by sulfhydryl groups, making it a potent antioxidant.

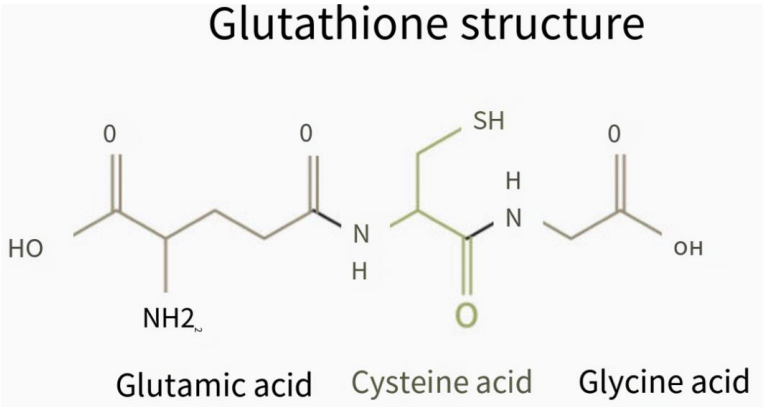

Figure 1. The structure of glutathione [8]

As Figure 2 shown, there are two forms of glutathione: the oxidized form, called GSSG, and the reduced form, called GSH. In the GSH state, it serves as an antioxidant by giving cells the electrons they need to combat dangerous free radicals and reactive oxygen species. Electrons are moved from GSH to the reactive oxygen species during this antioxidative activity, which results in the production of glutathione's GSSG form [9]. However, in order to maintain optimal antioxidant capacity within cells, glutathione's reduced form GSH must be converted back to its oxidized form GSSG [10]. Glutathione reductase is an enzyme that is essential to this repair process because it converts GSSG into GSH, which continues the antioxidation cycle.

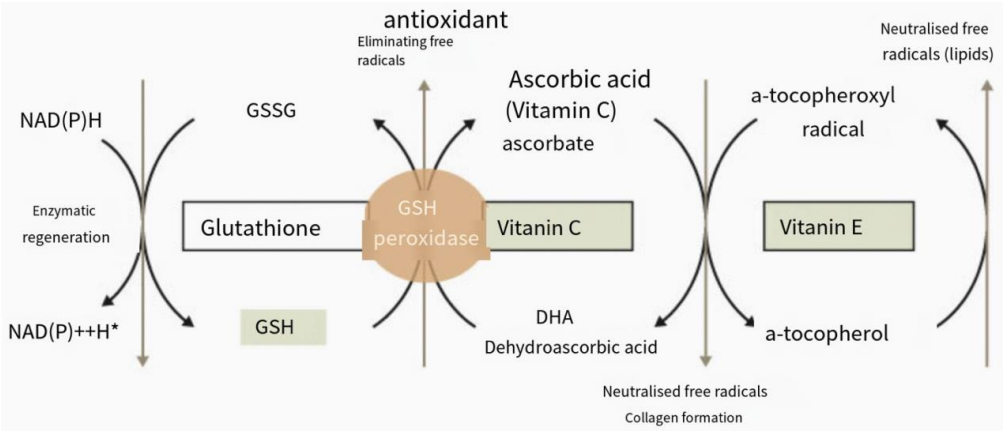

Figure 2. The antioxidant cycle of glutathione [11]

By counteracting reactive oxygen species and managing oxidative stress levels, glutathione plays a crucial role in maintaining cell vitality and reduces the likelihood of diseases associated with oxidative harm [12].

2.3. Taurine

Taurine, abundantly found in OPPs, is recognized for its extensive physiological functions. The unique chemical structure of sulfonic acid is distinguished from that of amino acids by the presence of both an amino group (-NH2) and a sulfonic acid group (-SO3H), and without a carboxyl group (-COOH) [13]. Although taurine has simple structures, it has many physiological effects. As shown in figure 3. Firstly, regulating calcium homeostasis, taurine ensures intracellular calcium balance and is essential for muscle contraction, neurotransmitter release, and enzyme activity. In addition, it has powerful antioxidant properties, clearing reactive oxygen species and free radicals and protecting cells from oxidative damage [14].

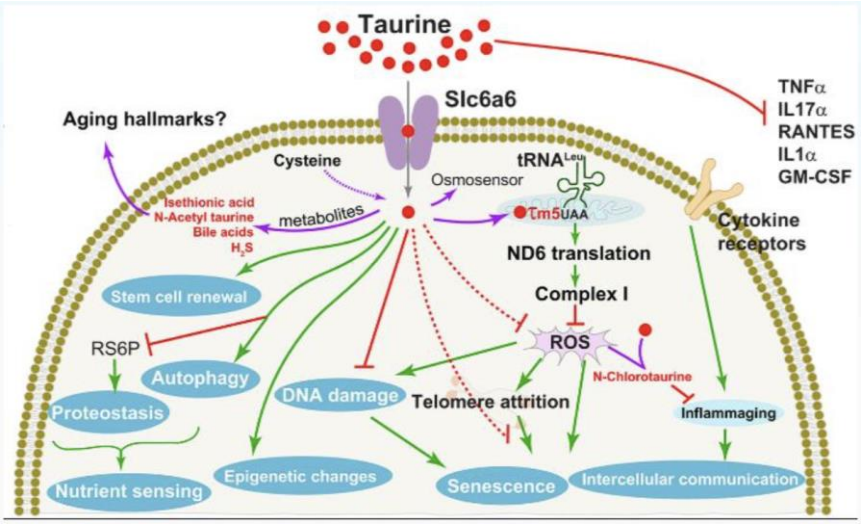

Figure 3. The reactions of taurine [15]

Moreover, taurine can regulate neurotransmitter receptors and ion channels in the brain to alter neurotransmission. Thus altering the reactivity of nerve cells and the transmission of information between synapses [16]. Last but not not least, taurine promotes osmotic regulation by regulating cell volume and maintaining cell integrity.

Serving as an organic osmolyte, it counteracts changes in osmotic pressure, preserving cell structure and function under osmotic stress conditions [17]. All those processes can show the importance of taurine in preserving comprehensive bodily health and wellness.

2.4. Zinc

OPPs contain a significant amount of the vital trace mineral zinc. It is crucial for immune function, DNA synthesis, and cellular metabolism. The high zinc content in oyster peptides enhances immune responses, helping protect the body against infections and diseases. Zinc also supports wound healing and the maintenance of skin integrity, making it beneficial for skin health [18]. It contributes to metabolic wellness by its involvement in the activity of enzymes and the production of proteins.

2.5. Polysaccharides

The polysaccharides present in OPPs have immune-enhancing properties. They can enhance the function of immune cells, including macrophages and natural killer cells, which are essential to the body's defense system [19]. This immune boost contributes to better defense against pathogens and a stronger overall immune response. And polysaccharides also have the potential to fight tumors and reduce inflammation, further promoting their medicinal advantages.

2.6. Vitamins and Minerals

Oyster extract peptides are rich in various nutrients, including vitamins B1, A, and D, which are essential for many biological processes. Building DNA, preserving brain function, and producing red blood cells all depend on thiamine (Vitamin B1). Vitamin D is necessary for calcium absorption and strong bones, while retinal (Vitamin A) supports immune system function, eye health, and skin health [20].

Together, these essential nutrients augment the overall health benefits and enrich the nutritive potency of OPPs.

2.7. Combined Effects

The bioactive substances in oyster protein peptides, such as essential amino acids, glutathione, taurine, zinc, polysaccharides, and various vitamins and minerals, work synergistically to provide a comprehensive range of health benefits.

As research shown, the action of glutathione as an antioxidant combined with the immune-boosting abilities of zinc and polysaccharides. Long-term use of OPPs can enhance the body's defenses and reduce the likelihood of persistent health conditions [21]. Taurine combines with zinc to promote heart and metabolic health, while key amino acids promote muscle tissue development and repair. In addition, it contains a range of vitamins and minerals that enhance the nutritional value of oyster peptide, making it a beneficial supplement for human health.

3. Conclusion

OPPs are rich in bioactive substances, including essential amino acids, glutathione, taurine, zinc, polysaccharides and various vitamins and minerals, which contribute to the health of all parts of the body. The essential amino acids in OPP support muscle health, energy production and blood sugar regulation. Among them, glutathione and taurine provide antioxidant effects, manage oxidative stress and support cellular health. Zinc can enhance immune function and skin integrity, while polysaccharides can enhance immune cell activity and have anti-inflammatory properties. In addition, vitamins B1, A, and D are essential for DNA synthesis, brain function, and bone health.

The results of the analysis highlight the importance of OPP in advancing functional foods and nutritional supplements. The health benefits of OPPs highlight their potential as a valuable ingredient in promoting healthy foods. This study raises awareness of the use of natural Marine resources to improve human health and promote sustainable development in the oyster farming and processing industry. These findings support the inclusion of OPP in dietary strategies to improve public health and address undernutrition. However, the bioavailability and long-term effects of OPPs on human health need further study. In addition, differences in OPP composition may affect its efficacy due to different processing methods and oyster species. Future research should focus on clinical trials to determine the therapeutic potential and safety of OPPs. Exploring the molecular mechanisms behind the bioactive effects of OPPs will provide greater insight into their health benefits. Moreover, developing standardized extraction and processing methods will ensure the consistency and utility of OPP-based products.

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