1 Marine-derived Peptides: Development and Health Prospects

Se-Kwon Kim[1,2] and Isuru Wijesekara[2]

[1]*Marine Bioprocess Research Center, Department of Chemistry, Pukyong National University, Busan, Republic of Korea*
[2]*Department of Chemistry, Pukyoung National University, Nam-Gu, Busan, Republic of Korea*

1.1 INTRODUCTION

The role of protein in the human diet has been acknowledged recently worldwide. Dietary proteins have become a source of physiologically active components, which have a positive impact on the body's function after gastrointestinal digestion. Bioactive peptides may be produced by one of three methods: solvent extraction, enzymatic hydrolysis and microbial fermentation of food proteins. Marine-derived bioactive food proteins and biopeptides are often effective in promoting health and lead to a reduction in the risk of disease. Recently, much attention has been paid by consumers to natural bioactive compounds as functional ingredients. Hence, it can be suggested that marine-derived bioactive food proteins and biopeptides are alternative sources for synthetic ingredients that can contribute to consumers' well-being, as a part of functional foods, pharmaceuticals and/or cosmetics. Furthermore, they can be utilized in other industries such as medicine, animal feed, printing, textile and so on. This chapter presents an overview of the development, health effects, industrial perspectives and commercial trends of marine-derived bioactive food proteins and biopeptides used in the food, pharmaceutical and cosmetic industries.

1.2 DEVELOPMENT OF MARINE PEPTIDES

Enzymatic hydrolysis of marine-derived proteins allows preparation of bioactive peptides, which can be obtained by *in vitro* hydrolysis of protein substrates using appropriate proteolytic enzymes. The physicochemical conditions of the reaction media, such as the temperature and pH of the protein solution, must then be adjusted in order to optimize the activity of the enzyme used. Proteolytic enzymes from microbes, plants and animals can be used for the hydrolysis process of marine proteins in order to develop bioactive peptides. Enzymatic hydrolysis is carried out under optimal conditions to obtain a maximum yield of peptides. For example, α-chymotrypsin, papain, Neutrase and trypsin have been applied to the hydrolysis of tuna dark muscle under optimal pH and temperature conditions for each by Qian *et al*. (2007).

One of the most important factors in producing bioactive peptides with desired functional properties for use as functional materials is their molecular weight (Deeslie & Cheryan, 1981). Therefore, for efficient recovery and in order to obtain bioactive

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peptides with a desired molecular size and functional property, an ultrafiltration membrane system can be used. This system's main advantage is that the molecular-weight distribution of the desired peptide can be controlled by adoption of an appropriate ultrafiltration membrane (Cheryan & Mehaia, 1990). In order to obtain functionally active peptides, it is normal to use three enzymes in order to allow sequential enzymatic digestion. Moreover, it is possible to obtain serial enzymatic digestions in a system using a multistep recycling membrane reactor combined with an ultrafiltration membrane system to separate marine-derived bioactive peptides (Jeon *et al*., 1999). This membrane bioreactor technology has recently emerged for the development of bioactive compounds and has potential for the utilization of marine proteins as value-added neutraceuticals with beneficial health effects.

1.3 HEALTH BENEFITS OF MARINE PEPTIDES

Marine-derived antihypertensive peptides have shown potent antihypertensive effect with angiotensin-I-converting enzyme (ACE)-inhibition activity. The potency of these marine-derived peptides has been expressed as an IC_{50} value, which is the the ACE-inhibitor concentration that inhibits 50% of ACE activity. The inhibition modes of ACE-catalyzed hydrolysis of these antihypertensive peptides have been determined by Lineweaver–Burk plots. Competitive ACE-inhibitory peptides have been reported most frequently (Lee *et al*., 2010; Zhao *et al*., 2009). These inhibitors can bind to the active site in order to block it or to the inhibitor-binding site remote from the active site in order to alter the enzyme conformation such that the substrate no longer binds to the active site. In addition, a noncompetitive mechanism has been observed in some peptides (Qian *et al*., 2007; Suetsuna & Nakano, 2000). Numerous *in vivo* studies of marine-derived antihypertensive peptides in spontaneously hypertensive rats have shown potent ACE-inhibition activity (Fahmi *et al*., 2004; Zhao *et al*., 2009).

Recently, a number of studies have observed that peptides derived from different marine-protein hydrolysates act as potential antioxidants; these have been isolated from marine organisms such as jumbo squid, oyster, blue mussel, hoki, tuna, cod, Pacific hake, capelin, scad, mackerel, Alaska pollock, conger eel, yellow fin sole, yellow stripe trevally and microalgae (Kim & Wijesekara, 2010). The beneficial effects of antioxidant marine bioactive peptides in scavenging free radicals and reactive oxygen species (ROS) and in preventing oxidative damage by interrupting the radical chain reaction of lipid peroxidation are well known. The inhibition of lipid peroxidation by marine bioactive peptide, isolated from jumbo squid, has been determined by a linoleic acid model system; its activity was much higher than α-tocopherol and was close to the highly active synthetic antioxidant BHT (Mendis *et al*., 2005b).

Marine-derived antimicrobial peptides have described in the hemolymph of many marine invertebrates (Tincu & Taylor, 2004), including the spider crab (Stensvag *et al*., 2008), oyster (Liu *et al*., 2008), American lobster (Battison *et al*., 2008), shrimp (Bartlett *et al*., 2002) and green sea urchin (Li *et al*., 2008). Antibacterial activity has been reported in the hemolymph of the blue crab, *Callinectus sapidus*; it was highly inhibitory to Gram-negative bacteria (Edward *et al*., 1996). Although there are several reports of antibacterial activity in seminal plasma, few antibacterial peptides have been reported in the mud crab, *Scylla serrata* (Jayasankar & Subramonium, 1999).

The anticoagulant marine bioactive peptides have rarely been reported, but have been isolated from marine organisms such as marine echiuroid worm, starfish and blue mussel. Moreover, marine anticoagulant proteins have been purified from blood ark shell and yellow fin sole. The anticoagulant activity of these peptides has been determined by prolongation of activated partial thromboplastin time (APTT), prothrombin time (PT) and thrombin time (TP) assays and compared with heparin, the commercial anticoagulant.

Biologically active marine peptides are food-derived peptides that exert a physiological, hormone-like effect beyond their nutritional value, and have a possible role in reducing the risk of cardiovascular diseases by lowering plasma cholesterol level and show anti-cancer activity through a reduction in cell proliferation on human breast-cancer cell lines. Moreover, calcium-binding bioactive peptides derived from pepsin hydrolysates of the marine fish species Alaska pollock (*Theragra chalcogramma*) and hoki frame (*Johnius belengerii*) can be introduced to Asians with lactose indigestion and intolerance as an alternative to dairy products (Kim & Wijesekara, 2010).

1.4 CONCLUSION

Marine-derived proteins and bioactive peptides have potential for use as functional ingredients in neutraceuticals and pharmaceuticals due to their effectiveness in both prevention and treatment of diseases. Moreover, cost-effective and safe drugs can be produced from marine bioactive proteins and peptides. Further studies and clinical trials are needed for these bioactive proteins and peptides.

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