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THE POTENTIAL OF MARINE COMPOUNDS IN REGENERATIVE MEDICINE

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Abstract
Marine ecosystems protect over 70% of the planet's surface and are also some of the most biodiverse and complex systems. From the perspective of biodiversity, the sea is a major reservoir, still largely untapped, of bioactive compounds produced from bacteria, plant, and animal species. Nonetheless, global warming coupled with several anthropogenic activities is a grave environmental issue that has resulted in the rise of gelatinous zooplankton, known as jellyfish bloom. The idea of "sustainable development" has been at the forefront of green economy activities for the past ten years, which has led to a revaluation and recognition of the marine ecosystem as a significant biological resource. Food, cosmetics, pharmaceuticals, and numerous more industrial applications are among its many uses. The purpose of this paper is to provide a current summary of the pharmacological and biological uses of marine collagen, such as cell therapy and regenerative medicine.
Keywords: marine collagen, jellyfish, chondrocyte maintenance, cell therapy

1. INTRODUCTION

Perhaps the most valuable natural food supply on Earth is the oceans, which mostly provide fish and shellfish[2]. However, the ecosystem is seriously threatened by a number of anthropogenic activities, including ocean acidification, pollution, eutrophication, coastal development, and the expansion of marine cultural activities and the resulting rise in nutrients [1]. These activities are also exacerbated by global climate change. Due to the lengthy history of overfishing, the Mediterranean Sea is home to a wide variety of sea species, including both native and non-native jellyfish. One of the main causes of the rise in jellyfish populations is overfishing, which eliminates both competitors and predators from the ecosystem[4]. Furthermore, the disposal of substantial volumes of trash from the fishing industry raises some environmental waste management issues. The effects of these factors on human activity and health in coastal waters are generally detrimental, and they all have important ecological and socioeconomic implications[6]. Due to its remarkable biodiversity, the sea provides a natural supply for most biologically active compounds [10]. Marine life creates a variety of strong and unusual compounds that are not found anywhere else because of their varied habitats and exposure to extreme environments[8]. Numerous marine materials have been found to possess a range of biological characteristics. For instance, it has been demonstrated that algal polysaccharides and fish peptides have anticoagulant and anticancer qualities[9].

Seaweed and crustaceans are rich in powerful antioxidants including carotenoids and phenolic compounds, while marine microbes and fish oils are rich in omega-3 fatty acids. Environmentally appropriate methods to the use of Earth's natural resources have been put into practice recently for both economic and environmental reasons [13][3]. Consequently, "Blue Growth" has been approved by the European Commission as a long-term framework to support sustainable development in the maritime industries[11]. The amount of study on the potential uses of marine collagen has increased dramatically during the last 15 years[12]. This illustrates how scientists are becoming more concerned about preserving the marine ecosystem and are eager to use its wealth of resources.

2. REVIEW OF LITERATURE

It is known that eating fish and seafood on a regular basis has health benefits. The concept of functional foods has been justified by the strong link between nutrition and health that was discovered in the middle of the 1980s[14]. Cholesterol-lowering diets, pre- and pro-biotics, and other functional foods can improve an organism's general health and minimize the risk of or even cure certain conditions including osteoporosis and cardiovascular disease. Seafood is a vital part of the Mediterranean diet, a nutritional pattern that is well regarded[16]. According to epidemiological research, residents in the Mediterranean Sea region have lower rates of chronic illnesses and live longer than those who live inland. Consumers' interest in food's nutritional value has increased dramatically in recent years. Customers will be able to choose healthier foods if they can recognize and encourage the nutrient-dense components in meals [15]. Because functional meals can prevent diet-related disorders and improve customers' physical and mental health, the concept has gained popularity[18].

Polyunsaturated fatty acids, now referred to as "good fats," particularly docosahexaenoic acid and eicosapentaenoic acid, are more important for the regulation of certain physiological processes than other animal protein sources [5]. Omega is especially involved in the prevention and treatment of numerous chronic issues, including neurological and cardiovascular ailments, as well as cancer. Omega consumption and its therapeutic effects on a variety of ailments have been linked in clinical trials and epidemiological studies. Additionally, the many naturally occurring bioactive chemicals that can be isolated from marine organisms have received a lot of attention lately. Few bioactive compounds have been found in pelagic cnidarians, however the majority of natural chemicals that are derived from marine creatures have many important applications for humans. Benthic cnidarians, such as corals and sea anemones, are the source of many of these compounds[15].

3. MATERIALS AND METHODS

In particular, the genes and proteins that regulate biomineralization have been produced by corals for a very long time; most of these are highly conserved and similar to those in humans. Although coral extracts are a plausible source of bioactive compounds, their usage is limited and mostly focused on their prospective use as scaffolds for grafting operations due to their structural and qualitative similarities to human bone. The purification of collagen from marine vertebrates like fish and marine mammals, as well as other oceanic sources like algae, and oceanic invertebrates like sea urchins, squid, prawns, and starfish, is probably one of the most important results of the revaluation of maritime sources. Paper and other products can use marine collagen from jellyfish as their main biological component. Recycling paper made from wood can be combined with recycling paper made from jelly. These compounds can be used to create highly biodegradable polymers, and cross-linkers made from renewable feedstocks can optimize their functioning. Given that plastic-induced pollution is a serious concern for today's civilizations, the environmentally friendly, sustainable manufacture of highly biodegradable polymers could find various uses both now and in the future [7].

In addition to biotechnological applications that aim to reduce environmental impacts, marine resources can have a sufficient place in the biomedical area. Algae, especially macroalgae, are a family of marine invertebrates that may be a valuable source of bioactive chemicals. Fucoidan is one of the most studied extracts from the algae group. Fucoidans are highly sulphated, fucose-rich polymers that are found in brown macroalgae in a densely branched form and in echinoderms in a less branching, more linear form. These are multipurpose marine polymers with a variety of uses, such as medicinal and antiviral ones. Because of its qualities, collagen is one of the most researched and used natural polymers in medicine, along with chitin and alginates. It contributes to the many structural and functional characteristics of cells and is necessary for the development of organs and tissues. The biological characteristics of collagen, such as its biodegradability and weak antigenicity, make it the most popular source of materials for biotechnological applications in tissue engineering in the biomedical sectors as well as in the cosmetic, nutraceutical, and pharmaceutical markets. Because of these significant characteristics, it is highly prized in the biomedical industry as a component of other products, including pharmaceutical systems and medical devices, as well as a functional ingredient in various formulations.

Mammals, especially pigs and cows, are the main source of collagen utilized in the biomedical and industrial sectors, while it was initially seen in early life in ancient species including sea anemones, corals, and jellyfish. Despite their many advantages, both bovine and porcine sources have certain disadvantages, such as unfavourable immunologic and inflammatory responses. For example, bovine collagen has limited use in biomedical sectors because over 3% of people are allergic to it. However, because pig collagen looks human, it does not cause severe allergic reactions. However, a lot of issues and complications arise because it can spread some zoonoses to humans, such as bovine spongiform encephalopathy, foot-and-mouth disease, and religious prohibitions, like the ban on bovine collagen in Hinduism and the ban on porcine collagen in Islamic and Jewish societies because of religious beliefs. Furthermore, environmental factors, such as the temperatures the fish live in, alter the acid composition of the fish, especially hydroxyproline, which affects the collagen's thermal stability. The collagen from warm-water species like bigeye tuna and tilapia was more thermally stable than that from cold-water fish like cod, whiting, and halibut.

4. RESULT AND DISCUSSION

Although it is difficult due to the many post-translational alterations that collagen experiences, producing collagen as a recombinant product could be one potential substitute. However, this method is highly costly. Many biotech companies are producing recombinant collagen without requiring animal sources by applying state-of-the-art methods. One company that has developed a plant platform that effectively expresses human collagen is Coll Plant. Genetically engineered tobacco plants were used to create a recombinant human collagen type. A modern recombinant collagen platform, known as "made by using exactly controlled conditions through a proven fermentation-based method," has been developed by Evonik, another biotech company[17].

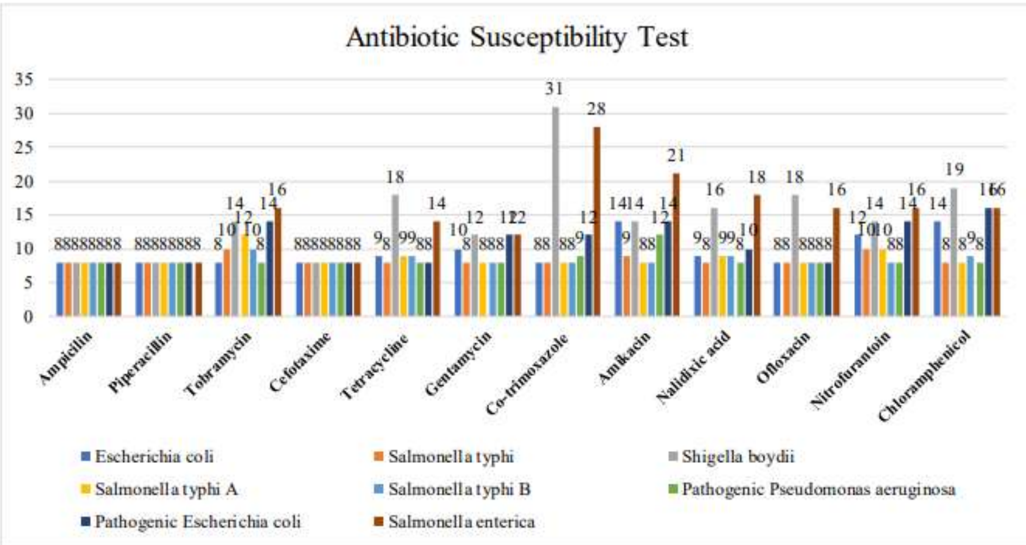

Figure 1: Diffusion method

An alternative and secure source of new bioactive peptides is provided by aquatic creatures. Many fish species, as well as invertebrates and vertebrates, such as sponges, sea urchins, octopi, squid, jellyfishes, cuttlefishes, starfishes, sea anemones, prawns, and coralline red algae, can be used to extract marine collagen. Collagen extraction procedures need to be carefully examined and modified to maintain the properties of collagen because it has been demonstrated that they can actually change those properties.

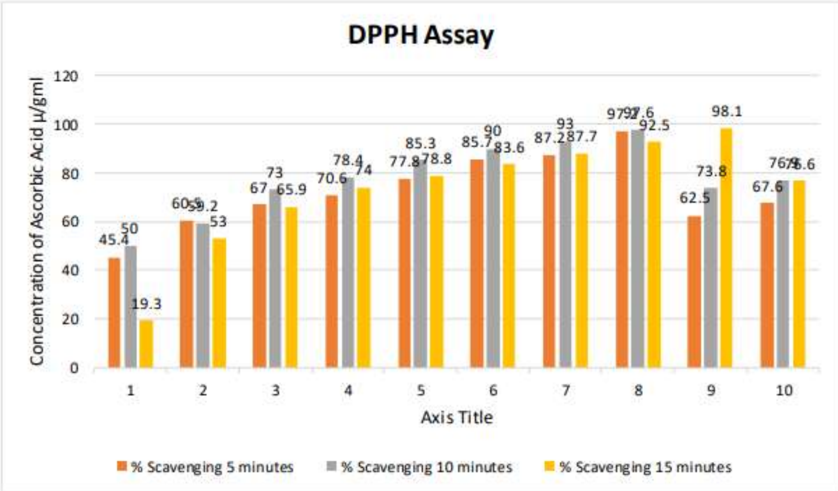

Figure 2: Results of anti-oxidant activity

The solubility of collagen in neutral saline solutions, acid solutions, and acid solutions enhanced with enzymes such as pepsin is the basis for the most widely used extraction methods; however, new extraction techniques such as the use of ultrasound sonication, electrodialysis, and isoelectric precipitation are also being researched in order to preserve the biological characteristics and inherent qualities of native collagen.

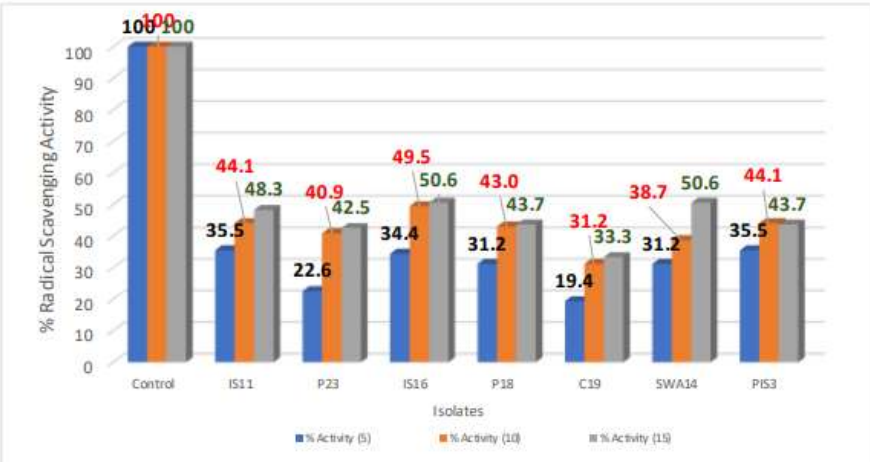

Figure 3: Results of anti-oxidant activity

Marine and mammalian collagen have varying acid composition, especially the proportions of proline and hydroxyproline in different fish are vastly different. However, the disadvantages of employing marine collagen are the previously noted increased rates of degradation, decreased mechanical strength, lowered denaturation temperature, and decreased biomechanical stiffness. However, the latter cannot create intra- and inter-chain linkages like those in human collagen without the use of chemical reagents. For this reason, in biomedical applications, marine collagen cannot completely replace mammalian collagen.

5. CONCLUSION

Marine collagen is currently receiving more attention because of its many biological activities and therapeutic potential, which includes anti-inflammatory and antioxidant activity, neuroprotective, anti-aging, and healing effects. It is also safe, biocompatible in the vast majority of biomedical applications, biodegradable, and has an improved ability to penetrate lipid-free interfaces. This material's vast potential allows it to be used as a sustainable platform for the biological valorization of fish wastes and as an alternative to animal collagens in pharmaceutical and cosmetic formulations. The effectiveness of collagen hydrolysate and its low molecular weight peptides in treating skin aging is undeniable, and doing so will enhance people's social and mental health. Unfortunately, employing marine collagen still has drawbacks that prohibit it from fully replacing mammalian collagen in biomedical applications, including a lower denaturation temperature and a higher rate of deterioration.

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