IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 14, Issue 11 Ser. II (November 2020), PP 52-55
www.iosrjournals.org

Extraction and Applications of Marine Collagen

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Abstract
Collagen is that the main protein of the connective tissue and its molecule is made by three polypeptide strands, named alpha chains. The foremost common motifs within the aminoalkanoic acid sequence of collagen are Gly-Pro-X and Gly-X-Hyp. Collagens are often extracted from the spread of organisms. The utilization of cattle because the main source for collagen has been reconsidered due to the bovine spongiform encephalopathy and transmissible spongiform encephalopathy, while porcine origin collagen is increasingly rejected for religious reasons. One alternative is that the extraction of collagen from marine sources. Sponges, jellyfishes, squids, octopuses, cuttlefishes, and fish offal (bones, skin, scales, and fins) can function an alternate source of collagen. Nowadays there's a high biotechnological interest of marine collagenous, as witnessed by a good pattern of applications in biomedicine, food science, and cosmetics.

Keywords: *Marine Collagen, Extraction, Applications.*

Date of Submission: 25-11-2020 Date of Acceptance: 09-12-2020

I. Introduction :

Collagen may be a group of present proteins. It's one among the long, fibrous structural proteins whose functions are different from those of globular proteins like enzymes. it's abundant in most invertebrates and vertebrates. It's the most protein of the connective tissue and represents about one-fourth of the entire protein content in many animals. The collagen molecule is made by three polypeptide strands, named alpha chains, and features a molecular mass of about 285 Kd. Each chain possesses the conformation of a left-handed helix. These three helices are twisted together to make a triple helix which is stabilized by hydrogen bonds. Collagen has high hydroxyproline content and its aminoalkanoic acid composition is sort of different from a typical protein. The foremost common aminoalkanoic acid sequence in collagen is Gly-Pro-X and Gly- X-Hyp, where X is any aminoalkanoic acid aside from glycine (Gly), proline (Pro), or hydroxyproline (Hyp). Several reports on invertebrates' collagen have emphasized its morphological and functional characteristics. There's a variable amount of covalent cross-linking between the collagen molecule helices. Those way well-organized aggregates, like fibrils, are forming. Collagen fibrils are the aggregation of several subunits, called tropocollagen (approximately 300 nm long and 1.5 nm in diameter). These fibrils are semi-crystalline aggregates of collagen molecules. Collagen fibres are bundles of fibrils. These fibres are a serious component of the extracellular matrix that supports most tissues and provides structure to the cells from the surface. Collagen exists in many places throughout the body. So far, 29 sorts of collagen are identified and described with types I, II, III, and IV to represent over 90% of the collagen within the body.

Marine Collagen

Collagen is often extracted from various organisms. Preferential sources of collagen are bovine skin and tendon also as porcine skin. The risks of the bovine spongiform encephalopathy and transmissible spongiform encephalopathy are the most reason that the utilization of cattle as the source for collagen has been reconsidered. Furthermore, porcine origin collagen is increasingly rejected for religious reasons. One alternative is that the collagen from marine sources. Sponges, jellyfishes, and fish offal like bones, skin, scales, and fins can function as an alternate source of collagen. Marine collagens are fibrillar and nonfibrillar as well; also have lower gelling and melting temperatures than the mammalian collagen but relatively higher viscosities than equivalent bovine forms. Fish collagen is heat-sensitive thanks to labile cross-links as compared to mammals. The serine, threonine, and methionine are increased, whereas in fish collagen, amino acids proline and hydroxyproline are reduced, compared with mammalian collagen. Large amounts of glycine have also been reported. especially, the amount of proline and hydroxyproline vary significantly among fish species depends on the environmental temperature during which the fish lives and it affects the thermal stability of the collagens. Most fish collagens are found to consist of two α - chains, which are normally designated as α-1 and α-2. These chain variants have approximately an equivalent relative molecular mass (95,000 Da). The existence of collagen in marine also as freshwater sponges were first proved electron microscopically in the 1980s. Studies have proven, by characterizing cDNA and genomic clones that in sponges there is a minimum of two gene families.

Even type IV collagen was demonstrated within the homoscleromorph sponge Pseudocorticiumjarrei by cDNA and genomic DNA studies.

Isolation of Collagen

There are three major methods for collagen extraction producing neutral salt solubilized collagen, acid solubilized collagen and pepsin solubilized collagen. Freshly synthesized and negligibly cross linked collagen molecules are extracted by neutral salt solutions.

Fish Collagen

Waste materials, like skin, bones, fins, and scales are generated in large amounts of 50-70% during fish processing. These waste materials are very rich in collagen and have received increasing attention as collagen sources. Many extraction methods are described for fish waste materials collagen.

Calcified tissues are another material than fish collagen is often extracted from. The extraction method for the calcified tissues is sort of different from those for the skin because these tissues need to be decalcified after the removal of the non-collagen proteins. Consistent with Nagai and Suzuki, bone collagen is often prepared from *skipjack, Japanese sea-bass, ayu, Yellow seabream,* and *horse mackerel*.

Sponge Collagen

Marine sponges are often an alternate source for collagen extraction. These animals, the foremost primitive of multicellular animals (Metazoa), are anatomically simple, a mass of cells formed of a porous skeleton made from organic (collagen fibres and/or spongin) and inorganic (spicules) components. The fibrillar collagen may be a huge component of the organic stuff in sponges. The nonfibrillar collagen (called spongin) encoded in sponges, maybe a short-chain molecule that shares features with basement membrane collagen, type IV.

Collagen was isolated from the sponge Geodiacydonium with a yield of 1.7 you bored with the absence of denaturing agents. It had the typical amino acid composition and was associated with the carbohydrates galactose and glucose. Approximately 30% glycine, 6% proline, 8% hydroxyproline, and 1% hydroxylysine. Sponge species of the family Superiditae are found to be rich in collagen. Collagens type I and IV were isolated and partially characterized by the marine demosponge, Irciniafusca. In agreement with earlier studies, sponge collagen was insoluble in dilute acid mediums. The amino acid composition of Chondrosia is analogous with Spongia and Ircinia. The collagen of Chondrosia has higher amino acid and phenylalanine content and lower glutaminic acid content. The share of glycosylated hydroxylysine is that the same in Chondrosia and Ircinia collagens, but the share of the entire lysine hydroxylated is far higher in Chondrosia collagen. consistent with Heinemann Fourier transform infrared reflection-absorption spectroscopy of the purified sponge collagen of Chondrosiareniformis showed remarkable analogy of peak positions and intensities with the spectra of fibrillar calf skin type I collagen, despite the various phylogenetic and evolutionary origin.

Other Marine Sourced Collagen

Jellyfish may be a prominent source for marine collagen extraction. Jellyfish has the potential to become a big source of collagen because its collagen content is quite 60%. Many investigations are concerned with collagen from jellyfish species, like *Rhopilemaasamushi*, *Stomolophusmeleagris*, *Catostylustagi*, and *Rhizostomapulmo* and report high collagen recovery rates. aminoalkanoic acid analyses revealed a composition similar to vertebrate collagen with, however, a lower content of hydroxyproline, which results in relatively low denaturation temperatures between 26 and 29.9 °C. a number of the jellyfish collagens are like vertebrate collagen IV or V [47,48] and a few show a singular structure with a fourth a-chain. Jellyfish collagen of *S. meleagris* that's almost like vertebrate collagen type II. The yield of jellyfish collagen extraction is about 35.2% on the idea of the lyophilized dry weight.

Cuttlefish outer skins could be another material for collagen extraction. Acid solubilized collagen and pepsin solubilized collagen was isolated from the outer skin waste of cuttlefish *Sepia lycidas* with the yields to be 2% and 35% respectively on the idea of the lyophilized dry weight. within the way of creating simpler use of underutilized fisheries resources, collagen was prepared from the octopus Callistoctopusarakawai arm. The arm was only slightly solubilized in ethanoic acid but on digestion with 10% pepsin (w/v), pepsin-solubilized collagen was successfully produced. The yields of acid-solubilized collagen and pepsin-solubilized collagen, on the idea of lyophilized dry weight, were about 10.4% and 62.9%, respectively. it's suggested that this collagen may be a heterotrimer with a sequence composition of $\alpha 1 \alpha 2 \alpha 3$. Kołodziejska proposed high yield acid-soluble collagen isolation from squid Illexargentinus whole skins (53% of the collagen contained within the skins might be extracted). Collagens, acid-solubilized and pepsin-solubilized, were also prepared from diamondback squid (*Thysanoteuthis rhombus*). The yield of acid-solubilized collagen was very low, about 1.3% on a dry weight basis while the yield of pepsin-solubilized collagen was very high, about 35.6% on a dry weight basis.

Marine Collagen Applications :

Thus far, the economic use of collagen has mainly been limited to vertebrate collagen. Among collagen alternatives, fish provide the simplest source of staple due to its high availability, no risk of disease transmission, no religious barriers, and the possibility of upper yielding collagen. Recent studies sparked a high biotechnological interest of collagenous extracts from fishes and marine sponges, as witnessed by a good pattern of applications in biomedicine, food science, and cosmetics. The fibrils of sponge *Irciniafusca* have a band periodicity of 67 nm with a 300 nm and height of 20 nm, which resembles the sort I human collagen. an identical ultrastructure and organization of collagen have also another marine sponge, *Chondrosiareniformisnardo*, while Boute reported the existence of collagen type IV in sponges. This suggests that purified collagens of marine sponges are just like the human types I and IV and should be safe alternatives to the potential harmful bovine originated collagens.

Marine collagen is being presented as an excellent ingredient for the cosmetic industry. it's anti-aging and anti-wrinkling factors, it is often used for the event of creams or gels with high moisturizing action and it seems to guard against the UV radiation. Collagen-based materials have got used to stopping moisture and warmth loss from wounded tissue while providing also as microbial infiltration barrier. A possible application of the *Chondrosiareniformis* extracted collagen as a moisturizer in cosmetic preparations was investigated by Swatschek using non-invasive in vivo measurement techniques. That study demonstrated that conventional collagen is often substituted by marine collagen. one of the foremost popular facial rejuvenation technics is the injectable fillers. Implantable collagen hydrogels are examined as agents for delivery chemotherapeutic agents. Liquid collagen supplement has been isolated from the marine origin and it proved to deliver collagen through the upper layer of the skin deep to the lower layers of the human epidermis. Development of collagen shields in ophthalmology, gel formulation together with liposomes as controlling material for transdermal delivery, mini-pellets, and tablets for protein delivery, and nanoparticles for gene delivery is another application of the marine collagen.

Collagen is that the most ordinarily used biomaterial in tissue engineering. Collagen extracted from higher vertebrates is typically more cross-linked and has a higher denaturation temperature that creates it less elastic and well-toned. Collagen from fishes is a smaller amount cross-linked and its solubility is far above others. Marine collagen generally is found to be about 60% purer than bovine collagen and far safer. Collagen-based scaffolds for tissue engineering applications are often prepared from jellyfish extracted collagen. Song generated porous scaffolds by freeze-drying and subsequent chemical cross-linking of acid solubilized jellyfish collagen. Biocompatibility (attachment of human fibroblast and immune reaction after implantation of the scaffolds in vivo) found to be almost like the other collagen sources. Tubular porous scaffolds from marine collagen reinforced with poly(lactic-co-glycolic) acid fibres were developed by freeze-drying and electrospinning techniques. These constructs were cultivated to check the influence of electrospinning parameters on cell adhesion and proliferation. Another sort of porous scaffold was established by Lee, combining jellyfish collagen and mucopolysaccharide. Hoyer manufactured porous 3-D jellyfish collagen scaffolds with an interconnected pore structure by freeze-drying and subsequent chemical cross-linking. it had been a cytocompatible matrix with the potential to support and maintain chondrogenic stimulation of human mesenchymal stem cells.

II. Conclusion :

Collagen is additionally important to the food processing industry. Edible films and coatings are a singular category of packaging materials, differing from other bio-based packaging materials or conventional packaging. They're formed from edible ingredients, like collagen. Such films prepared from mammalian collagen have found a variety of uses within the area of drug release agents within the field of drugs. O'Sullivan with ethanoic acid extraction successfully recovered collagen from fish skins and this collagen was subsequently wont to produce collagen films, demonstrated its potential as a film-forming ingredient. During a later study, the acid-soluble collagen from *Alaska pollacksurimi*refinerdischarge, having a thermal denaturation temperature slightly above that for *Alaska pollack* skin, was proposed as a potential functional food ingredient. The soluble form (acid-soluble or pepsin-soluble) marine collagen can also be used as an emulsifier. Collagen gained in acid-soluble form from surimi refiner discharges had higher emulsifying activity (EA) than both acid-soluble collagen from the skin and therefore the commercial emulsifier, Tween-80. Emulsifying capacity is a particularly important functional property in food processing, and it's been studied extensively in such food systems as myofibrillar proteins. The emulsifying capacity (EC) of collagenous material from the muscle and skin of hake (*Merlucciusmerluccius*) and trout (*Salmoirideusgibb*) are demonstrated by Montero and Borderías. Expressed in terms of the number of soluble protein, EC is often considered higher within the collagenous material from the hake than therein from the trout, and better within the muscle animal tissue than within the dermal animal tissue.

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RafatunisaNahri. “Extraction and Applications of Marine Collagen.” *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*, 14(11), (2020): pp 52-55.