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Review Article

BIOPROSPECTING OF SHELLS OF CRUSTACEANS

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ABSTRACT

Chitin is the second most important natural biopolymer from the shells of crustaceans in the world. Development of chitosan industries on commercial scale would also generate employment opportunities which are most essential for developing countries like India. Quite a few kinds of polysaccharides occur in nature in a broad range of structures and forms, and most of them are considered to work as structural materials or suppliers of water and energy, though their functions may not have been fully comprehended. We discuss chitosan, the most important derivative of chitin, outlining the best techniques to characterize and it is many applications.

Keywords: Crustaceans, Chitin, Crustaceans, Chitosan and Biopolymer.

INTRODUCTION

Crustacea is a class of organisms under the phylum Arthropoda, which includes crabs, lobsters, barnacles and shrimps. All arthropods have exoskeletons and jointed appendages. The class Crustacea includes arthropods that breathe using gills or branchiae, and possess two pairs of antennae. Most marine arthropods are crustaceans. Among marine crustaceans shrimp is the single largest item landed in India. Since polysaccharides have peculiar structures and properties, quite different from those of synthetic polymers, they are considered promising biopolymers for developing desirable advanced functions. Among numerous polysaccharides, cellulose and chitin are produced in the largest amounts, estimated estimated to be around 10^{11} tons each per year, and actually, they are the most abundant organic compounds on earth. Chemically modified chitin and chitosan structures resulting in improved solubility in general organic solvents have been reported by many workers[1-10]. The present review is an attempt to discuss the current applications and future prospects of chitin and chitosan.

CHITIN AND CHITOSAN

Chitin and chitosan the naturally abundant and renewable polymers have excellent properties such as, biodegradability, biocompatibility, non-toxicity, and adsorption [11]. The reaction of chitosan is considerably more versatile than cellulose due to the presence of NH_2 groups. Various efforts have been made to prepare functional derivatives of chitosan by chemical modifications [12], graft reactions, ionic interactions, and only few of them are found to dissolve in conventional organic solvents [13]. Chitin and chitosan are natural resources waiting for a market. They were waste products of the crabbing and shrimp canning industry. Chitin produced as processing waste from shellfish, krill, clams, oysters, squid, and fungi. Commercially chitin and chitosan are of great importance owing to their relatively high percentage of nitrogen compared to synthetically substituted cellulose.

BIOLOGICAL APPLICATION OF CHITIN AND CHITOSAN

Antimicrobial activity of chitosan

Antimicrobial activity of chitosan has been demonstrated against many bacteria, filamentous fungi and yeasts [14-17]. Chitosan has wide spectrum of activity and high killing rate against Gram-positive and Gram-negative bacteria, but lower toxicity toward mammalian cells [18-19]. Ever since the broad-spectrum antibacterial activity of chitosan was first proposed by Allen [20], along with great commercial potential, the antimicrobial property of chitosan and its derivatives have been attracting great attention from researchers. Investigation of the antimicrobial properties of chitosan has been a long journey of scientific exploration and technological development. The journey began two decades ago, with studies on the biological phenomena arising from foodborne and soilborne pathogenic fungi in the food and agriculture industries [21].

Antioxidant activity of chitosan

Chitosans showed were good in antioxidant properties, especially antioxidant activity, scavenging ability on hydroxyl radicals and chelating ability on ferrous ions. In addition, the prolonged N-deacetylation resulted in chitosan with more effective antioxidant properties. Chitosan with presumed antioxidant properties may be used as a source of antioxidants, as a possible food supplement or ingredient or in the pharmaceutical industry [22]. Antioxidant properties of chitosan derivatives have been studied [23-25]. Furthermore, antioxidant properties of fungal chitosan from *shiitake stipes* have also been studied [26].

Biosorption of heavy metal ions in aquous solution.

Nowadays, biosorption is a strongly explored technique; it is defined as passive, not involving metabolically mediated processes, with the property to bind metals by living or dead biomass [27]. Considerable attention has been paid to the recovery and removal of valuable heavy metal ions from industrial and municipal wastewater by using various biosubstances or natural products, particularly because of the low cost and high availability of these materials, without needing arduous regeneration process for reuse, being capable of binding heavy metals by sorption, chelation and ion exchange processes [28-29]. These low-cost abundant natural materials such as chitin, chitosan, alginate, cellulose, peat and biomass require little processing and are abundant in nature, mainly when obtained as by-products and waste from industry [30].

Anticoagulant activity of chitosan

The chemical modification of the amino and hydroxyl groups can generate products for pharmaceutical applications, for example: sulfated chitosans possess a wide range of biological activities. Thus, chitosan sulfates as the nearest structural analogues of the natural blood anticoagulant heparin, demonstrate anticoagulant, antisclerotic and antiviral activities [31-35].

Wound healing property of chitosan

Chitosan, a derivative of the biopolymer chitin, has been extensively applied in biomedical and pharmaceutical research because of its low toxicity and good biocompatibility. It is able to accelerate the reepithelialization and normal skin regeneration [36], and to confer considerable antibacterial activity against a broad spectrum of bacteria [37-38]. Chitosan (poly D-glucosamine, deacetylated derivative of chitin) and its oligomers are well known for their interesting biological properties, which have led to various applications such as drug delivery carriers, surgical thread, bone healing materials, and especially wound dressing [39-40].

Antitumour and hepatoprotective effect of chitosan

Chitooligosaccharides (COSs), derivatives of chitosan, can be obtained by either enzymatic or acidic hydrolysis. COSs has been the choice of interest among many researchers due to their potential biological activities such as immunity enhancing and antitumor [41], antioxidant and radical scavenging activity [42-44] and hepatoprotective activity [45].

Hypocholestermic and antidiabetic activity of chitosan

Chitosan, a biopolymer of glucosamine derived from chitin that is chemically similar to that of cellulose, is not digestible by mammalian digestive enzymes and acts as a dietary fiber in gastrointestinal tract [46]. It is well known for its cholesterol-lowering effect. However, relative less information is available about the effect of chitosan on plasma lipids and glucose control in diabetic subjects. Previous study has reported that chitosan reduced the concentration of plasma cholesterol in animals [47,48,49,50] and type II diabetes patients in combination with hypercholesterolemia [51]. Increased fecal cholesterol accompanied with or without bile acid excretion by interfering intestinal micelle formation was proposed to be the mechanisms responsible for the hypocholesterolemic properties [46,49,50]. One of the recently reports demonstrated that chitosan has a hypoglycemic effect in STZ-induced diabetic animals [52]. Other studies also found that low molecular weight chitosan (average MW about 2.0 $X10^4$ Da) [53,54], as well as chitosan oligosaccharides [55], can reduce plasma glucose level in diabetic animals.

CHITOSAN BASED MATERIALS

Chitosan is used to prepare hydrogels, films, fibers or sponges, most of the materials are used in the biomedical domain, for which biocompatibility is essential. Many systems are described in the literature, but we can cite only a few of the most promising. Chitosan is much easier to process than chitin, but the stability of chitosan materials is generally lower, owing to their more hydrophilic character and, especially, pH sensitivity. To control both their mechanical and chemical properties, various techniques are used, as mentioned previously for chitin. Often, the methods are adapted from the cellulose world.

ECONOMIC VALUE OF CHITOSAN

To produce 1 kg of 70% deacetylated chitosan from shrimp shells, 6.3 kg of HCl and 1.8 Kg of NaOH are required in addition to nitrogen, process water (0.5 t) and cooling water (0.9 t). Important items for estimating the production cost include transportation, which varies depending on labor and location. In India, the Central Institute of fisheries Technology, Kerala, initiated research on chitin and chitosan. From their investigation, they found that dry prawn waste contained 23% and dry squilla contained 15% chitin [56]. They have also reported that the chitinous solid waste fraction of the average Indian landing of shell fish ranges from 60 000 to 80 000 tonnes [57,58]. Chitin and chitosan are now produced commercially in India, Japan, Poland, Norway and Australia.

CONCLUSION

Crustacean shell waste is usually dried on the beaches. It encourages not only environmental pollution but also reduces the recoverable components from their biowaste. Solid Crustacean shell waste undergoes rapid putrefaction because of its alkaline nature (pH 7.5–8.0). Due to high perishability of Crustacean shell waste, implemented processing is needed. Improving the design and operation of biological treatment process for shrimp waste in real life application presents many challenges, including working within the following constraints: the need for robust operation, environmental parameters, and low cost operation. Therefore, extensive research should be carried out to explore bioactive compounds and their activities from Crustacean shell waste.

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