World Applied Sciences Journal 37 (2): 140-148, 2019
ISSN 1818-4952
© IDOSI Publications, 2019
DOI: 10.5829/idosi.wasj.2019.140.148

Bio-Medicinal and Economic Biotechnology Benefits of Shrimp Shell Waste and their Applications

Manal Esam Shafi

Department of Biological Sciences, Faculty of Science, P.O. Box 80203,
King Abdulaziz University, Jeddah, 21589, Saudi Arabia

Abstract: The second seafood product sold worldwide is shrimp, which accounts for 8% of the total marketing value of fish products. In Saudi Arabia aquaculture, white shrimp (*Litopenaeus vannamei* and *Penaeus semisulcatus*) are the most commonly used shrimp species. Because of its high commercial value, the food industry in Saudi Arabia has processed a significant portion of these crustaceans, which also produce large amounts of biological waste from shrimp. About 40% of this trash is chitin. In nature, chitin is one of the most common biopolymers and is an important part of the supporting tissues in some organisms such as insects, fungi and crustaceans. as raw material chitin is usually used to generate chitin-derived products, oligosaccharides, chitosan's and glucosamine. Shrimp Chitin is closely correlated to proteins, mineral deposits, pigments and lipids. Although, these sources of raw materials require pretreatment. The use of shrimp shell waste has not been proposed as a solution to environmental problems, but it has also been proposed as an alternative to the treatment of shrimp shell waste. The crustacean remains contain 35% protein, 45% calcium carbonate and 25% chitin and vary in season and species. The usages of chitin as a by-product in many applications such as in biotechnology dentistry, medicine, veterinary medicine, chemistry, food industry, agriculture, textile production and environmental protection. Development of technologies focused on polyelectrolyte properties, ability to form gels, their capacity and high absorption, biodegradability, fungistatic, bacteriostatic and antitumor influence. Therefore over 2000 specific applications, it is the largest consumer of chitin and chitosan in the fields. Global industrial production is estimated to exceed 10,000 tons in 2000.

Key words: Applications · Shrimp Shell Waste · Chitin · Chitosan · Deproteinization · Demineralization · Broiler Diet

INTRODUCTION

Shrimp is one of the main fishery products in the world, including Saudi Arabia; in frozen condition, this product was mainly exported that have undergone the process of removing the exoskeleton and head. This dissociation process allows to adverse impacts on solid waste, leading to environmental pollution in the form of aesthetic damage and unpleasant odors to the environment. this essential by-product─considering a great economic value to the chitin and chitosan industries [1, 2].

A serious environmental problem obtains from the disposal of this amount of waste, although this waste is biodegradable, the rate of decomposition of a large amount of waste generated as a result of treatment is relatively low. Accumulation of such waste prolonged with time in an affected environment, leads not only to unpleasant smell, but also to insect's attention, flies and infected rodents, creating unhealthy atmosphere. Apparently, the immediate solution of such problem is the rapid processing of shrimp shells of mollusks. Production and extraction of commercially viable substances for use in other areas [3].

In Bangladesh [4] it is noted that about 40-50% of shrimp is lost in the form of legs, appendages, head, shell and tail. Shrimp processing industries also produce a large amount of waste, which varies from 40 to 80% depending on the type and process. In a processing plant, except for the largest freshwater shrimp head, the waste from other shrimp is usually treated as waste and discarded from the plant's premises within the facility.

Corresponding Author: Manal Esam Shafi, Department of Biological Sciences, Faculty of Science, P.O. Box 80203, King Abdulaziz University, Jeddah, 21589, Saudi Arabia. E-mail: meshafi@kau.edu.sa.

case. This unauthorized waste disposal has always paved the way for serious environmental pollution. At each plant, additional labor is used, or money is spent on the disposal of this valuable waste from the plant's premises within the facility. This unauthorized waste disposal has always paved the way for serious environmental pollution. At each plant, additional labor is used, or money is spent on the disposal of this valuable waste from plant capacity [5].

Chitin is the second most abundant polysaccharide on earth after cellulose and forms a linear chain from the group of acetylglucosamine [6]. It is a linear polysaccharide consisting of (1-4) Units of 2-acetamido-2-deoxy-D-glucose which may be deacetylated to some extent [7]. Younes and Rinaudo [8]. In shrimp shells, chitin is part of a complex of proteins on which calcium carbonate is deposited to form a hard shell. The interaction between chitin and protein is very narrow, with a small fraction of the protein involved in polysaccharide-protein complexes [9]. Therefore, isolation of chitin from the shrimp shell requires removal of the two main shell components, deproteinization of protein and calcium mineral carbonate by demineralization and generally small amounts of pigment and lipids. In some cases, an additional bleaching step is used to remove the residual pigment. Many methods have been proposed and used for many years to obtain pure chitin [8]. Azuma *et al.* [10] Chitin has been reported as the main structural component of the crab and shrimp exoskeleton, as well as the cell wall of fungi and yeasts [11]. The estimated annual sales are 1010 to 1011 tons (6.7). This makes chitin one of the most common biopolymers. Chitin can be easily obtained by simple extraction [12].

Thus, although raw materials are cheap, good chitin can cost up to $ 200 per kilogram. There is little worldwide industrial use of purified chitin (membranes for the supply of pharmaceuticals, food and cosmetics), about 10,000 tons per year. There are several applications of chitin in China, Japan, Thailand and Indonesia. The conversion of chitin or chitosan to other chemicals causes additional problems. Natural chitin is a crystalline substance that prevents the reactant from easily accessing the polymer chain. Under difficult reaction conditions, the chains can easily undergo side reactions involving the formation of various complex compounds. The separation of bio-based products from the reactor often takes a long time. In our view, these issues are no different than converting woody biomass to biofuels and other chemical products, which took 20 years to move from commercial scale to the laboratory. Creative chemistry is needed to create a viable and sustainable scrap industry. In order to separate proteins, calcium carbonate and chitin, a permanent fractionation method is necessary to avoid caustic or harmful reagents and to minimize waste. New technology is born. For example, teams from Mexico and the United Kingdom have shown a lactic acid-based fermentation process to produce chitin in the laboratory and pilot plant in the early 2000s. This process has enabled processing of up to 30-50 kg of debris in the reactor. Groups 6, 7 and 8 in the UK, US and China have developed a mixture of bacteria that consume proteins that degrade calcium carbonate. Protein hydrolysates and calcium lactate are useful by-products for animal feed and calcium supplements [13].

Since chitin is not easily soluble in common solvents, it is often the deacetylated derivative, chitosan. Although it is known that chitin and chitosan have important functional activities, their use in foods and biomedical applications is difficult because of their low solubility. In contrast, hydrolysis products of chitosan-N-acetyl-D-glucosamine oligomers (chitin oligosaccharides, NACOS) and D-glucosamine oligomers (chitosan oligosaccharides, COS) have shorter chains that are readily soluble in water. The high solubility of low viscosity and neutral pH COS has attracted the interest of many investigators to use chitosan as an oligosaccharide. NACOS and COS are produced by acid hydrolysis, hydrolysis, physical methods and enzymatic division and depolymerization of Chitin or Chitosan [13]. Recently, many publications have shown that NACOS and COS have many biological activities. Recently, the anticancer and anti-inflammatory effects of orally administered NACOS or COS have been described. This article focuses on these characteristics of NACOS and COS and first summarizes the results of previous studies and then analyzes the effectiveness of NACOS and COS as functional foods in cancer. The utility of COS derivatives for inflammation [10] drug delivery/targeted gene therapy has also been extensively studied. Chitosan-oligosaccharide derivatives of stearic acid (CSO-SA) have been studied as potential vectors for intracellular administration of antineoplastic agents [14].

Recently, we studied the anticancer properties of NACOS and COS, which were orally administered to mouse models of colon cancer using an enterocyte system [15]. Tumor volumes were significantly lower in animals treated with COS (2% and 4%) or NACOS (2% and 4%) than in the control group ($p < 0.05$). Many studies have reported the anti-inflammatory effects of COS. Exposure to COS reduces the secretion of nitric oxide (NO), i.e. the secretion of lipopolysaccharide

(LPS) in the culture medium, to study the effect of COS on LPS-stimulated RAW 264.7 cells [10]. Inflammatory bowel disease (IBD) includes ulcerative colitis (UC) and Crohn's disease and is characterized by chronic enteritis [16]. Over the past 40 years, the incidence of IBD has increased regularly in some parts of the world, probably due to dietary changes. (including low fiber intake) in these areas [17]. The role of the anti-inflammatory effect of COS in inflammatory bowel disease of the human colon epithelial cell line. However, the exact mechanism underlying the NACOS and COS effects has not been fully explored and new mechanistic studies are needed to use NACOS and COS in therapy. Recently, the beneficial effects of chitin and chitosan-based nanomaterials have also been reported. It is necessary to conduct research on practical applications such as the combination of chitin and chitosan in nanomaterials and NACOS and COS. The aim of this study overview on bio-medicinal and economic biotechnology benefits of shrimp shell waste and their applications [17].

The Uses of Chitin and Chitosan: Natural and non-toxic biopolymers, chitin and chitosan, are currently produced mainly on a commercial basis from the remnants of the shell of crabs and shrimp. In recent decades, chitin and chitosan have attracted considerable interest, given the variety of proposed new applications [18]. Their unique properties, biodegradability, biocompatibility and non-toxicity make them useful for a wide range of applications [19]. Its current practical applications in biotechnology with some attempts use. Applications include: 1) cationic agents for the treatment of polluted wastewater, 2) agricultural products, 3) additives for food and feed, 4) agents that reduce cholesterol, 5) biomedical and pharmaceutical materials, 6) products for wound healing, 7) anticoagulants, antithrombogens and hemostats, 8) cosmetic ingredients, 9) textile sheet materials, paper, films and sponges, 10) media for chromatography and immobilization and 11) reagents for analysis.

Wastewater Treatment with Chitin and Chitosan: Chitin and chitosan can be used to adsorb or bind heavy metals [20], remove and bind heavy metals and (elimination/reduction). Metal ions from wastewater, copper, chromium and cadmium, lead, nickel and mercury, iron, silver, zinc, cobalt and arsenic [21] and dyes (removal and fixation of dyes) (chitosan is an effective polycation polymer for coagulation, flocculation and dewatering activated sludge [18] and therefore is used to clean wastewater [18], immobilize microorganisms or sludge in chitosan matrices to clean wastewater in extreme environmental conditions (extreme pH values, the presence of organic solvents), reuse the use of cells and consequently its continuous implementation [19].

Applications of Chitin and Chitosan in Food: Very little attention has been paid to the use of these universal biopolymers [22]. They offer a wide range of unique applications. The use of chitosan in the food industry is related to its functional properties and nutritional and physiological activities. Chitosan can bind water, oil and paints and has emulsifying properties. It has been found to be useful in the preparation of stable emulsions without other surfactants. An interesting feature was used as a dietary supplement. Chitosan inhibits the growth of fungal and phytopathogenic fungi and causes the plant to resist fungal, viral or viroidal infections. However, low molecular weight chitosan oligomers lose their ability to prevent microbial growth and protect plants from pathogenic microorganisms [23] Research has been carried out for use in food processing and preservation of microorganisms responsible for food spoilage and various pathogenic microorganisms and antimicrobial activity of chitosan and N-sulfobenzoylcytosan.

Biomedical Application of Chitin and Chitosan: Chitin and chitosan exhibit excellent biological properties. For example, a daily dose limit of 17 g / kg [24] biocompatible [25], immunological, antibacterial, scar [26]. Hemostatic activity in cell culture, tissue engineering and drug delivery, gene delivery. Because it is very biocompatible and biodegradable in the physiological environment. Chitin is also used as an adjuvant and a drug in film, gel or powder form for mucoadhesive applications. Also as burns and bandages in humans and animals, antitumor activity, artificial skin, pharmacy, as nerve vessels for nerve regeneration due to its ability to facilitate administration. Therapeutic tumor therapeutic agents (chitin and 5-fluorouracil-chitosan conjugate), self-hardening paste for direct tissue regeneration in the treatment of periodontal disease (hydroxyapatite-chitin-chitosan, filler) and spermicidal Medicine [19].

Other Applications of Chitin and Chitosan Derivatives: Chitin and its derivatives can effectively reduce soilborne diseases. In addition, chitin serves several functions, including the retention of nutrients in the soil, which contributes to the nitrogen cycle [27]. Chitin and chitosan have potential universal application in agriculture (plant inducers [28], stimulation of chitinase activity in compost (changes in genetic diversity of bacteria and fungi) and antimicrobials As an (antimycotic) and biopesticides, it has the ability to increase vitality and destroy the fungal wall upon entry as a fertilizer and biocontrol agent, by adding rhizosphere bacteria it also increases the effectiveness and contributes to the effectiveness of chemical control. Under certain conditions, chitin is also converted to sugars. Slow degradation of microbial fuel cells It is also used as a substrate [19].

N-acetyl-D-Glucosamine: Another use of chitin is the preparation of N-acetyl-D-glucosamine which is currently used as dietary supplement and for the treatment of ulcerative colitis and other gastroenteritis [29]. This compound can be obtained by cleavage or enzymatic hydrolysis of chitin in eggs in a cold solution of 70% H 2 SO 4. Chitin endochitinase plays a role in biological degradation. They produce high molecular weight oligosaccharides and eco-histases; they essentially release the dimers and some trimers from the non-reducing end of the high molecular weight. Finally, chitobiose hydrolyzes the dimer to form N-acetyl-D-glucosamine. These enzymes are produced by many microorganisms that can collect salmon chitin. Among them, Gram-negative bacteria Serratia marcescens was chosen as one of the best chitosanases and chitobiose manufacturers. Aloise *et al.* [29] an effective method for producing N-acetyl-D-glucosamine was developed using extracellular kinolytic enzymes separated by chitin cultures based on ultrafiltration of chitin cultures based on Serratia marcescens. The mixture of chitinase and humanism is sufficiently effective. Effective hydrolysis of chitin particles in a fixed bed reactor the final product containing about 85% N-acetyl-D-glucosamine and 15% ketide is separated by ultrafiltration through a membrane from the reaction medium [23, 29].

Chitosan and Cosmetics: Chitosan and its derivatives are used as raw materials for various cosmetics, toothpaste, hand and body creams and hair care products. These biopolymers have also been studied as components of cosmetic compositions which are particularly suitable for sensitive skin. Depending on molecular weight and degree of deacetylation, chitosan has a moisturizing effect on the skin and protects the skin from mechanical damage to the hair and antistatic effects on the hair. High molecular weight chitosan increases the water resistance of the emulsion, prevents the penetration of sunlight and consequently improves the ability to form a film. The beneficial effects of the epidermal layer are also fibroblast activation and increased collagen deposition. In addition, the film-forming and protective properties of chitosan protect the skin from possible microbial infections. In addition, glucosamine chitosan affects the development of the desired glycosaminoglycan and glycoprotein structures in the extracellular matrix of the skin. Toothpaste and toothpaste containing chitosan reduces dentin penetration. Chitosan in these products forms a hydrogel that can close the dental tubule and protect it from microbial infection while maintaining proper ion and water distribution [23].

Agricultural and Aquaculturally: Chitin is also used as a material for agriculture and aquaculture. Chitin may be useful as a component of prescription fish foods and interesting effects on fish deserve further evaluation. There is evidence that fish and aquatic animals have intestinal bacterial communities, which are clearly different from those reported in the environment and diet. As a result, the intestinal environment provides some niche and bacterial activity in the intestine is not simply a continuum of activity observed in the environment. Nowadays, it is thought that the intestinal microbiota of fish is regulated by food manipulations [30].

Chitin and Textile Industry: Chitin and its derivatives can be used in the textile industry to produce synthetic fibers and to produce fiber fibers, coatings and auxiliary fabrics [31, 32]. And the acetic acid solution in the clotting solution. However, the kit fibers and derivatives have relatively low tensile strength. Furthermore, chitosan fibers obtained by rotation of aqueous acetic acid due to the chemical attack of coagulation are less than 5.5 at pH and require more modification. Thus, chitin and its derivatives are used only as a coating material for cellulose fibers, nylon, cotton and wool. The use of these modified fibers includes the manufacture of bandages, medical fabrics, sanitary napkins and undergarments, non-allergic sportswear and socks, deodorants and antimicrobials. The addition of chitin to the tarpaulin cover significantly increases the water vapor permeability. In addition, the processing of wool fibers with chitin derivatives increases their dyeability and staining resistance [23].

Two Methods for Chitin Extraction from Shrimp Shell Waste: In shrimp skeletal tissue, proteins and chitin combine to form a matrix of chitin proteins, which are then mostly fired to form a solid shell of shrimp. Residues also contain lipids and carotenoids, mainly astaxanthin and its esters [33]. The traditional industrial method for producing chitin (exoskeleton) from crustaceans is called chemical method and consists of two main steps: (i) separation of proteins, which called deproteinization by alkaline treatment and (ii) then separation of calcium carbonate (and phosphate from calcium), **i.e.** desalting by acid treatment high temperature, bleaching with chemical reagents to obtain colorless product [34, 35]. Another way to solve the chemical extraction problem is to use biological methods. The use of proteases to deproteinize crustacean shells prevents alkaline processing. In addition to the use of exoenzymes, proteolytic bacteria have been used to deproteinize desalting membranes [19, 36].

The Shrimp Shell Waste and Deproteinization: The protein is a high molecular weight (MW) polypeptide. Proteins play an important role in the metabolic functions of organisms and thus in human health. Shrimp waste contains proteins of inadequate quality, peptides derived from shrimp waste. Penaeus shrimp shells contain all essential amino acids and have a nutritional value comparable to soy meal. The protein removal step of chitin-protein is difficult because the chemical bond between chitin and the protein is broken. Complete elimination of the protein is particularly important for biomedical applications since a percentage of the human population is allergic to mollusks and is the main cause of the protein component [37].

The Biomedical Applications of Shrimp Shell Protein: Used shrimp waste to make peptides and test them for anti-cancer and anti-cancer activity. The objective is to hydrolyze shrimp protein (complete in its shell) using food grade clotting enzyme to obtain gut resistant peptides and to evaluate the suppressive effect of colon cell proliferation and liver cancer. Shrimp shells: whole lobster shrimp from El Salvador (South America), shrimp shells from St. Petersburg, Florida (United States) and shrimp shells from the Gulf of Mexico in Louisiana (United States) rated the near-field fraction of anti-cancer peptides derived from shrimp residue-derived proteins may enable new uses for nutraceutical ingredients [38].

Proteins and Peptides from Shrimp Shell Waste Used Their Chemopreventive Properties Against the Carcinogenic Effects: Shrimp-shell derived peptides can be used as alternative interesting polymers because of their superior properties such as non-toxic products, low cost and slightly undesirable side effects and are very acceptable to consumers [39]. In the original protein sequence, the biologically active peptides are inactive, so they are absorbed by the protein, but they can be released by hydrolysis of the protein [40]. In the intestine to reach target organs that may have many physiological effects on the human body [41]. Due to the lack of toxicity observed for these bioactive peptides for cellular health [42], the efficacy of bioactive peptides with the anti-cancer ability (SWSP) seems to be anti-cancer activity in the population Risk of chronic diseases. The small size of these peptides worldwide allows them to be used as peptide-based pharmacological therapies that act through certain mechanisms against cancer cells [43]. 1) Inhibition of micellization by the cytoplasmic membrane. 2) Cell apoptosis 3) Interaction between this peptide and ganglioside [44], The mechanism of use of these peptides as an anticancer activity is not yet known. There are good results in the treatment of cancer, such as surgery, chemotherapy and radiotherapy, which are currently used, which are expensive and have many side effects. Bioactive polymers are common natural and dietary products and can provide important health-related relationships to reduce or prevent chronic diseases (e.g., cancer) [45, 46].

Applications of Shrimp Shell Protein in Food: Shrimp powder can be an important source of high-quality proteins due to its abundance and low cost. Value-added products, such as protein-enriched shrimp biscuits, can be made from unused shrimp containers. Salted shrimp crackers can be a high-quality source of protein for malnourished people and shrimp powder can be used in other foods for protein concentration [4].

In Bangladesh the national shrimp processing industry releases 30,000 tons of shrimp waste per year [5]. Shrimp waste was an excellent opportunity to produce value-added products for humans, animals and fish feed, as well as valuable medicines such as chitin and chitosan. Most shrimp processing plants are well equipped with modern technology lines with the help of the state, in accordance with the requirements of the FDA and the EC. Value-added foods can be produced in the existing treatment chains if the usual precautions are taken. The products can be sold on the site or for export. Khan and Novad [4], are economical and environmentally friendly technologies that allow us to use food from the shrimp industry and produce it for human consumption. Develop Shrimp crackers are a variety of fried foods and bakery products and are well known in ASEAN countries.

The cookies are called "croup" in Indonesia, in Malaysia, in British English and in American English. This is a popular snack in some parts of East and Southeast Asia. The production technology of shrimp biscuits is very simple, which requires fewer complex machines. In Bangladesh, no attempt has been made to formulate and develop food and other value-added products from shrimp waste. In view of the above, it has been suggested that it is necessary to design and develop a protein-rich shrimp biscuit from unused shrimp residues. It has been found that the waste components of the shrimp shell have very good nutrient content. High levels of protein, 40 to 50% of which were found in shell waste. The lipid content of shrimp shells varied from 3.4 to 3.8% and the ash content from 14.6 to 22.7% [4].

Demineralization to Eliminate the Inorganic Material Such as Calcium Carbonate from Shrimp Shell Waste: Mathematics is mainly produced in the form of calcium carbonate while removing minerals. The demineralization is usually carried out by acid treatment with HCl, HNO3, H2SO4, CH3COOH and HCOOH [13]. Calcium carbonate is easily calcined because it breaks down when carbon dioxide is released into the water-soluble calcium salt. Most of the other minerals in refined nail polish react in the same way by forming soluble salts in the presence of acid. The salt can be easily separated by filtering the phase of the solid kit and then washing with deionized water. Calcium carbonate is widely used in the pharmaceutical, agricultural, construction and paper industries. Today, they are mainly geological sources such as marble and limestone. These sources are abundant but may contain heavy metals which are difficult to remove. Therefore, chalk is suitable for example, as a component of tablets for human consumption. It may be easier to take medicine from a food source than stones. The market price of ground calcium carbonate is about $ 60 to $ 66 per ton of coarse particles, pigments, fillers and tillage used in construction. Ultrafine particles can reach $ 14,000 per ton. Even though shellfish calcium carbonate has been converted to larger particles cheaper in Southeast Asia, it's market value may reach $ 45 million [13].

Eliminating Discoloration of Shrimp Shell: Astaxanthin (3,3'-dihydroxy-â, â-carotene-4,4'-dion) is the main carotenoid and main natural carotenoid pigment in shellfish found in shrimps (filet and shell). The main compound responsible for the color of typical pink salmon. Carotenoids often form strong bonds with proteins and fatty acids. Thus, enzymatic digestion and hydrolysis were demonstrated prior to treatment with unshelled carotenoids [47]. Shrimp is an orange-orange source [48]. Antioxidant effect [49] contains vitamins C and E. It creates such holistic partners [50] or protects the body from diabetic diseases [51]. Neoplasia, hypertension, [52] and atherosclerosis. However, due to the conjugated double bond structure, astaxanthin is sensitive to light, temperature, acidity and oxidation reactions. To increase the market value of this exclusion, other names have been applied to the use of this material, natural carotenoids also have antioxidant properties that are superior to those of synthetic and their consumers. more natural products. The use of shell shrimp for the preparation of functional foods is increasingly an alternative to high value added for this waste [53].

Shrimp Waste as Substitutes for Fish Meal and Broiler Diet: Commercial production of chickens has become a specialized sector to produce modern poultry in developing countries. However, high-quality food does not meet the requirements of the source of animal protein in Bangladesh. The cost of food was 60-65% of the total cost of protection and 13% of the total cost of producing animal feed [54, 55]. Fish meal is a common, but more expensive, food ingredient of animal origin. Shrimp (SW) waste is a byproduct of the shrimp processing industry. They consist mainly of shrimp heads, tails and shells, which are dried and crushed in the sun or in an oven. In 1991, the availability of the NE was estimated at 60,000 tons for Bangladesh [56]. Currently, SW is widely used as feed for birds in this country. To reduce the cost of food, it is necessary to find a cheaper source of protein for poultry in order to form an econometric regime with non-traditional foods, such as SW and WM [57].

CONCLUSION

Hundreds of tons of shrimp shell waste are generated each year during shrimp processing and consumption, such as in Taiwan, Indonesia, India or Bangladesh. The main ingredients (dry weight) of shrimp waste are chitin, proteins, polysaccharides, minerals and carotenoids. Chitin molecules are regulated regularly in shrimp shells in the helical microfibrillar structures material. which closely associated with proteins, minerals, lipids and pigments.

The importance of chitin and chitosan biopolymers lies in its biological properties (biodegradability, biocompatibility and non-toxic) and physicochemical properties (degree of acetylation and molecular weight). These unique features offer many potential applications in different areas. Recently, they are widely used in agriculture, medicine, food industry, environmental protection and biotechnology.

N-acetyl-D-glucosamine oligomers (chitin oligosaccharides, NACOS oligomers) and D-glucosamine oligomers (chitosan oligosaccharides, COS) have different biological properties against cancer and inflammation. In the next five years, we need to start a multi-million-dollar project and set up the first technology channel using new technology. The project is supported by a government rich in mollusks and should be implemented by researchers. Catalyst, materials science and engineering, food science and life cycle analysis. Companies including seafood producers and sellers, biomaterials-related and biomaterials and other renewable materials developers will consider the potential market for cost-effective and environmentally friendly waste. In the next decade, strict rules for recycling and incentives for companies that use them may be introduced.

Recent studies on the nature and use of chitin and its derivatives indicate the development of new technologies using these polysaccharides is thought to play an important role in the formation of new industrial zones. Shrimp wastes were rich in protein and minerals, including Ca, P, Na and Zn. The amino acid profile of dried shrimp shells was higher and the ratio of saturated to unsaturated fatty acids was 1: 1.63. The total saturated fatty acid content was found to be lower than the total unsaturated fatty acid content and the high nitrogen and phosphorus content.

REFERENCES

1. Kim, S.K. and I. Wijesekara, 2010. Development and biological activities of marine-derived bioactive perptides: A review. J. Funct. Foods, 2: 1-9.
2. Patria, A., 2013. Production and characterization of Chitosan from shrimp shells waste, AACL Bioflux, 6(4): 339-344.
3. Allwin, J.S.I., K.I. Jeyasanta and J. Patterson, 2015. Extraction of Chitosan from White Shrimp (Litopenaeus vannamei) Processing Waste and Examination of its Bioactive Potentials, Advances in Biological Research, 9(6): 389-396.
4. Khan, M. and A.K.M.A. Nowsad, 2012. Development of protein enriched shrimp crackers from shrimp shell wastes, J. Bangladesh Agril. Univ., 10(2): 367-374.
5. Nowsad, A., 2005. End of Assignment Report-Marine Fish Processing and Product Development. Food and Agriculture Organization of the United Nations, Dhaka, pp: 77.
6. Norhidayah, M. Ahyat, Faridah Mohamad, Azrilawani Ahmad and Alyza A. Azmi, 2017. Chitin and chitosan extraction from Portunus pelagicus, Malaysian Journal of Analytical Sciences, 21(4): 770-777.
7. Einbu, A., S.N. Naess, A. Elgsaeter and K.M. Vårum, 2004 Solution properties of chitin in alkali, Biomacromolecules, 5: 2048-2054.
8. Younes, I. and M. Rinaudo, 2015. Chitin and Chitosan Preparation from Marine Sources. Structure, Properties and Applications, Mar. Drugs., 13: 1133-1174.
9. Crini, G., E. Guibal, M. Morcellet, G. Torri and P.M. Badot, 2009. Chitin and Chitosan. Preparation, Properties and Main Applications. In: Chitin and Chitosan. Application of Some Biopolymers, University Press of Franche-Comté, Besançon, France, pp: 19-54.
10. Azuma, K., T. Osaki, S. Minami and Y. Okamoto, 2015. Anticancer and Anti-Inflammatory Properties of Chitin and Chitosan Oligosaccharides, J. Funct. Biomater., 6: 33-49.
11. Azuma, K., S. Ifuku, T. Osaki, Y. Okamoto and S. Minami, 2014. Preparation and Biomedical Applications of Chitin and Chitosan Nanofibers. J. Biomed. Nanotechnol., 10: 2891-29 20.
12. Kjartansson, G.T., S. Zivanovic, K. Kristbergsson and J. Weiss, 2006. Sonication-assisted extraction of chitin from North Atlantic shrimps (Pandalus borealis), J. Agric. Food Chem., 54: 5894-5902.
13. Yan, N. and X. Chen, 2 0 1 5. Don't waste seafood waste, Comment, 13: 5 2 4, 1 5 5-157.
14. Huang, X., X. Huang, X.H. Jiang, F.Q. Hu, Y.Z. Du, Q.F. Zhu and C.S. Jin, 2012. In vitro antitumor activity of stearic acid-g-chitosan oligosaccharide polymeric micelles loading podophyllotoxin. J. Microencapsul., 29: 1-8.
15. Masuda, S., K. Azuma, S. Kurozumi, M. Kiyose, T. Osaki, T. Tsuka, N. Itoh, T. Imagawa, S. Minami, K. Sato and Y. Okamoto, 2015. Anti-tumor properties of orally administered glucosamine and N-acetyl-D-glucosamine oligomers in a mouse model. Carbohydr. Polym., 111: 783-787.
16. Morrison, G., B. Headon and P. Gibson, 2009. Update in inflammatory bowel disease. Aust. Fam. Phys., 38: 956-961.

17. Rose, D.J., M.T. DeMeo, A. Keshavarzian and B.R. Hamaker, 2007. Influence of dietary fiber on inflammatory bowel disease and colon cancer: Importance of fermentation pattern. Nutr. Rev., 65: 51-62.
18. Kurita, K., 2006. Chitin and chitosan: Functional biopolymers from marine crustaceans, Marine Biotechnol., 8: 203-226.
19. Arbia, W., L. Arbia, L. Adour and A. Amrane, 2013. Chitin Extraction from Crustacean Shells Using Biological Methods - A Review, Food Technol. Biotechnol, 51(1) 12-25.
20. Bhatnagar, A. and M. Sillanpää, 2009. Applications of chitin- and chitosan-derivatives for the detoxification of water and wastewater - A short review, Adv. Colloid Interface Sci., 152: 26-38.
21. Camci-Unal, G. and N.L.B. Pohl, 2009. Quantitative determination of heavy metal contaminant complexation by the carbohydrate polymer chitin, J. Chem. Eng. Data, 55: 1117-1121.
22. Toyoda, H., Y. Matsuda, T. Fukamizo, T. Nonomura and S. Ouchi, 1996. Application ofchitin-and chitosan-degrading microbes to comprehensive biocontrol of fungal pathogen Fusarium Oxysporum. In: Muzzarelli, R.A.A., Eds., Chitin Enzymology, Grottammare: Atec Edizioni, pp: 3549-370.
23. Synowiecki J. and N.A. Al-Khateeb, 2003. Production,Properties and Some New Applications of Chitin and Its Derivatives, 43(2): 145-171.
24. Yang, Y.P., X.H. Xu and H.F. Chen, 2004. Treatment of chitin-producing wastewater by micro-electrolysis-contact oxidization, J. Zhejiang Univ. Sci., 5: 436-440.
25. Majtán, J., K. Bíliková, O. Markovi~, J. Grόf, G. Kogan, J. Šimúth and Isolation 2007. characterization of chitin from bumblebee (Bombus terrestris), Int. J. Biol. Macromol., 40: 237-241.
26. Koide, S.S., 1998. Chitin-chitosan: Properties, benefits and risks, Nutr. Res., 18: 1091-1101.
27. Shahidi, F.R., 2005. Abuzaytoun, Chitin, chitosan and co-products: Chemistry, production, applications and health effects, Adv. Food Nutr. Res., 49: 93-135.
28. Ait Barka, E., P. Eullaffroy, C. Clément and G. Vernet, 2004. Chitosan improves development and protects Vitis vinifera L. against Botrytis cinerea, Plant Cell Rep., 22: 608-614.
29. Aloise, P.A., M., Lumme and C.A. Haynes, 1996. N-acetyl-D-glucosamine production from chitin-waste using chitinases from Serratia marcescens. In: Muzzarelli, R.A.A., Chitin Enzymology, Atec Edizioni, pp: 581-593.
30. Ringo, E., Z. Zhou, R.E. Olsen and C.C. Song, 2012. Use of chitin and kill in aquaculture effect on gut microbiota and the immune: review aquaculture. Nutr., 18: 117-131.
31. Hudson, S.M., 1997. Application of chitin and chitosan as fiber and textile chemicals. In: Domard, A., Roberts, G.A.F. and Varum, K., Eds., Advances in Chitin Science, Lyon: Jacques Andre Publishers, pp: 590-599.
32. Wieczorek, A. and M. Mucha, 1997. Application of chitin derivatives and their composites to biodegradable paper coatings. In: Domard, A., Roberts G.A.F. and Varum K.M., Eds., Advances in Chitin Science, Lyon: Jaques Andre Publisher, pp: 890-896.
33. Kjartansson, G.T., S. Zivanovic, K. Kristbergsson and J. Weiss, 2006. Sonication-assisted extraction of chitin from North Atlantic shrimps (Pandalus borealis), J. Agric. Food Chem., 54: 5894-5902.
34. No, H.K. and E.Y. Hur, 1998. Control of foam formation by antifoam during demineralization of crustacean shell in preparation of chitin, J. Agric. Food Chem., 46: 3844-3846.
35. Choorit, W., W. Patthanamanee and S. Manurakchinakorn, 2008. Use of response surface method for the determination of demineralization efficiency in fermented shrimp shells, Bioresour. Technol., 99: 6168-6173.
36. Jung, W.J., G.H. Jo, J.H. Kuk, Y.J. Kim, K.T. Oh and R.D. Park, 2007. Production of chitin from red crab shell waste by successive fermentation with Lactobacillus paracasei KCTC-3074 and Serratia marcescens FS-3, Carbohydr. Polym., 68: 746-750.
37. Younes, I. and M. Rinaudo 2015. Chitin and Chitosan Preparation from Marine Sources. Structure, Properties and Applications, Mar. Drugs., 13: 1134-1174.
38. Kannan, A., N.S. Hettiarachchy, M. Marshall and S. Raghavan, 2011. Kristinsson H. Shrimp shell peptide hydrolysates inhibit human cancer cell proliferation, J Sci Food Agric., 15;91(10): 1920-4.
39. Silva-Sánchez, C., A.P.B. de la Rosa, M.F. León-Galván, B.O. de Lumen, A. de LeónRodriguez and E.G. de Mejia, 2008. Bioactive peptides from amaranth (Amaranthus hypochondriacus) seed. J. Agric. Food Chem., 56: 1233-1240.
40. Sarmadi, B.H. and A. Ismail, 2010. Antioxidative peptides from food proteins: A review. Peptides, 31(10): 1949-1956.

41. Erdmann, K., B.W. Cheung and H. Schröder, 2008. The possible roles of food-derived bioactive peptides in reducing the risk of cardiovascular disease. The Journal of Nutritional Biochemistry, 19(10): 643-654.
42. Rodrigues, E.G., A.S. Dobroff, C.P. Taborda and L.R. Travassos, 2009. Antifungal and antitumor models of bioactive protective peptides. Anais da Academia Brasileira de Ciências, 81: 503-520.
43. Barras, D. and C. Widmann, 2011. Promises of apoptosis inducing peptides in cancer therapeutics. Current Pharmaceutical Biotechnology, 12(8): 1153-65.
44. Huang, Y.B., X.F. Wang, H.Y. Wang, Y. Liu and Y. Chen, 2011. Studies on mechanism of action of Anticancer Peptides by Modulation of Hydrophobicity within a defined structural framework. Molecular Cancer Therapeutics, 10(3): 416-426.
45. Bidwell, G.L. and D. Raucher, 2009. Therapeutic peptides for cancer therapy. Part I—Peptide inhibitors of signal transduction cascades. Expert Opin. Drug Deliv., 6: 1033-1047.
46. Hernández-Ledesma, B. and H. Chia-Chien, 2017. Chemopreventive role of food-derived proteins and peptides: A review, Critical Reviews in Food Science and Nutrition, 57(11): 2358-2376.
47. Sowmya, R. T.M. Ravikumar, R. Vivek, K. Rathinaraj, and N.M. Sachindra, 2014. Optimization of enzymatic hydrolysis of shrimp waste for recovery of antioxidant activity rich protein isolate. Journal of Food Science and Technology, 51: 3199-207.
48. Armenta, R.E. and I. Guerrero- Legarreta, 2009. Stability studies on astaxanthin extracted from fermented shrimp byoproducts. Journal of Agricultural and Food Chemistry, 57: 6095- 6100.
49. Hussein, G., U. Sankawa, H. Goto, K. Matsumoto and H. Watanabe, 2006b. Astaxanthin, a carotenoid with potential in human health and nutrition. Journal of Natural Products, 69: 443-449.
50. Chong, E.W., T.Y. Wong, A.J. Kreis., J.A. Simpson, R.H. Guymer, 2007. Dietary antioxidants and primary prevention of age-related macular degeneration: Systematic review and meta-analysis. BMJ Case Reports, 13(335): 723-729.
51. Kim, Y.J., Y.A. Kim and T. Yokozawa, 2009. Protection against oxidative stress. inflammation and apoptosis of high-glucoseexposed proximal tubular epithelial cells by astaxanthin. Journal of Agricultural and Food Chemistry, 57: 8793-8797.
52. Hussein, G., H. Goto, S. Oda, U. Sankawa, K. Matsumoto and H. Watanabe, 2006a. Antihypertensive potential and mechanism of action of astaxanthin: III. Antioxidant and histopatological e?ects in spontaneously hypertensive rats. Biological and Pharmaceutical Bulletin, 29(4): 684-688.
53. Lira, G.M., A.M.Q. Lopez, G.O. Firmino, S.D. Santos and R.S. Bezerra, 2006. Total carotenoids and antioxidant activity of fllets and shells (in natura or cooked) of “Vila Franca” shrimp (Litopenaeus Schmitti) in di?erent intervals of storage under freezing, Ciência e Agrotecnologia, 41(1): 94-103.
54. Singh, R.A., 1990. In: Poultry Production. 3rd edition. halyany Publishers, New Delhi, Ludhiana.
55. Banerjee, G.C., 1992. In: Poultry. 3rd Edn. Oxford and IBH Publishing Co Pvt. Ltd. New Delhi, Bombay, Calcutta.
56. Haque, Q.M.E. and M.M. Rahman, 1993. Annual Research Report of Bangladesh Livestock Research Institute, Savar, Dhaka, pp: 1341.
57. Aktar, M., M. Rashid, M.G. Azam1, M.A.R. Howlider and M.A. Hoque, 2011. Shrimp waste and marine waste as substitutes of fish meal in broiler diet, Bang. J. Anim. Sci., 40(1-2): 18-22.