International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Comparative Analysis of Chitin and Chitosan from Marine and Freshwater Prawns

Priyanka Thounaojam[1], Mujeeb Abdul Jaleel Shaikh[2]

[1]Department of Zoology, AKI's Poona College of Arts, Science and Commerce, Camp, Pune – 411001 (Maharashtra) India

[2]Department of Zoology, AKI's Poona College of Arts, Science and Commerce, Camp, Pune – 411001 (Maharashtra) India
Corresponding Author Email: *mujeebshaikh2003[at]yahoo.com*

Abstract: ***Worldwide nonedible shells of prawns, which comprises near about half the weight of prawns are adding lot of environmental pollution. Considering the weight of waste, present investigation was focused to convert the raw shells of all major marine P. monoceros, P. indicus, P. monodon and freshwater M. rosenbergii prawns species into usable chitin and chitosan. Concentration of both the chitin and chitosan in all the four species is done to determine the maximum yielding species. All the experimental species shell waste were subjected to methodology of deproteinization, demineralization, deacetylation for extraction and determination of concentrations of chitin and chitosan. The results indicated chitin yield was highest 3.6% for P. monoceros and Chitosan yield was found to be highest in M. rosenbergii having 34.93%. These findings helps in determining species specific extraction and commercial viability of chitin and chitosan as these are of great importance owing to their relatively high percentage of nitrogen compared to synthetically substituted cellulose. Chitosan have been identified as versatile biopolymer of natural origin for food addictive and preservative due to their non –toxicity, antioxidant activities and antimicrobial action.***

Keywords: Chitin, Chitosan, prawns, shell waste.

1. Introduction

In recent years, prawn fisheries in India became main industries economically providing a great deal to foreign exchange. Prawn is one of the leading fishery products in India, in frozen conditions, this output was mainly exported that have undergone the process of removing the exoskeleton and head. About 136000 tons of frozen prawns (2007-2008) worth Rs 34400 million were exported from India [1]. Asian countries like China, Thailand, Taiwan and India have emerged as global leaders in prawn production [2].

The shellfish wastes constitute 50% of the industrial fish processing wastes in India, their low biodegradability forms a significant disposal complication that actively affects the marine food industry to seek alternate means to dispose such waste cautiously to value added outputs. The demand for shellfish meat in the market has raised the proliferation of wastes generated by peeling before export. In 2021, around 690 peeling sheds were reportedly functioning in India with a capacity of 10,859.04 metric tons of prawns. According to 2021 statistics, in India there are 611 seafood processing units with a daily processing capacity of 34,495.95 metric tons. The CMFRI (Central Marine Fisheries Research Institute) reported that the non-penaeid prawns and penaeid prawns landing were 100,749 tons and 156,434 tons, respectively (2020). Maharashtra state has about 52,001 ha of potential brackish water area all along its coastline. In 2020, the prawn productivity in Maharashtra is 4.70 tons/ha/year [2].

In India, the Central Institute of Fisheries Technology (CIFT), Kerala initiated research in chitin and chitosan. From their inspection, they found that dry prawn waste contained 23% chitin [3]. Over the past few years, research has focused on exploring the potential of chitin, chitosan application especially within the areas of the food industry, health care and environmental application. The global market for chitosan increased more than 300% from the year 2015 to 2018 and is projected to continue at a CAGR (Compound Annual Growth Rate) value of 20.8% until 2025 [4]. Chitin and chitosan are now produced merchantable in India, Japan, Norway, Australia, Poland, France, Ecuador. Crustacean shell mainly consists of 30-40% protein, 30-50% calcium carbonate and 20-30% chitin depending on species and season [5].

Chitosan is quite complementary to cellulose. Chitosan is widely used in various fields namely the field of nutrition (lowering cholesterol levels, weight, fiber sources), food (nutritional, flavor preservatives), cosmetics (hair care, moisturizing creams, lotions) and in the environmental field (waste treatment).

Prawn shell waste encourages not only environmental pollution but also reduces the retrievable components from their bio waste [6]. Enhancing the design and process for prawn waste in real life usage presents many objections. Thus, extensive research should be accomplished to explore bioactive compounds and their activities from prawn shell waste.

2. Material and Methods

Deproteinization: 50g of samples were taken in a conical flask. In the conical flask, 225 ml of 4% Sodium hydroxide was added. The sample was incubated for 22 hours at 25° - 37° Celsius (i.e., room temperature). The following day the sample was filtered out with the help of filter paper and the liquid filtrate was collected separately in a beaker.

Demineralization: The liquid filtrate was taken in a conical flask, then 4% hydrochloric acid was added (1:4 w/v ratio). It was set at 25° - 37°C for 22 hours. One day later the liquid was filtered out using Whatman filter paper and solid filtrate was collected clearly. Then the filtrate was washed with D/W and dried in the hot air oven for 1 hour at 50°C. This solid filtrate is chitin. The weight of the chitin yield was measured and noted.

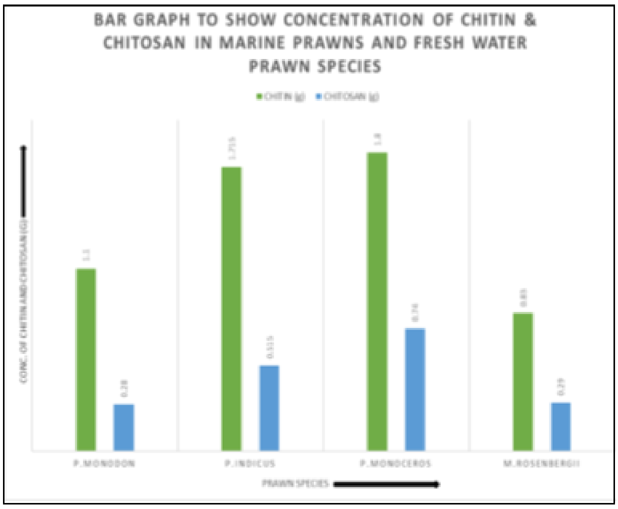
Deacetylation: In a conical flask, chitin translucent were treated with 50% sodium hydroxide (1:20 w/v ratio). It was incubated at 25° - 37° Celsius for 72 hours (i.e.,3 days).On the 4th day, the sample was filtered through Whatman filter paper and the solid filtrate was collected separately. The solid filtrate was washed with D/Wand dried in the hot air oven for 40 mins at 50°C. The weight of chito San was measured and noted.

3. Results and Discussion

Table 1: Concentration of Chitin and Chitosan in different species of prawns

S. No	Species	Shell Powder (G)	Chitin (G)	Chitosan (G)
1	*P.Monodon*	50g	1.100g	0.28 g
2	*P.indicus*	50g	1.715 g	0.515 g
3	*P. monoceros*	50g	1.800 g	0.74 g
4	*M. rosenbergi*	50g	0.83 g	0.29 g

The table shows that the chitosan is synthesized from 50g of each prawn shell powder. In the present study, the chitosan yields excessively in the Penaeus monoceros species having 0.74g. After then it is the *Penaeus indicus*, *Machrobrachium rosenbergii* and *Penaeus monodon* having the amount of 0.515g, 0.29g and 0.28g respectively. These chitosan were seized from three species of marine prawns and one from freshwater prawn through the same way. It is witnessed vividly in the above table.



The chitin yield was 3.6% for *P. monoceros* followed by 3.43% yield for P. indicus and then followed by 2.2% yield for P. monodon and 1.66% yield for *M. rosenbergii*. Chitosan yield was found to be highest in *M. rosenbergii* having 34.93%. Then it is followed by *P. monoceros*, *P. indicus* and *P. monodon* having the value 20.55%, 15.01% and 12.72%, respectively.

The extraction of chitin from the prawn shells is the initial step of the chitosan synthesis with the removal of the proteins from the prawn shells followed by demineralization for the removal of mineral ions presented in the shells which will be preceded by the deacetylation of the chitin that would result in chitosan [7]. Chitin is an abundant natural biopolymer synthesized by a number of living organisms and functions as a structural polysaccharide while chitosan is a versatile, non-toxic copolymer extracted from chitin by deacetylation [8].

Various chemical modifications have been investigated to try and improve the preparation of chitin and chitosan [9,10, 11]. In the present study, the yield chitin and chitosan extracted was lower than that reported by Zia et al., [3]. This may be due to the difference in the presence of these two polysaccharides in the shells of different prawn species. In this present study, the chemicals used are harsh, non-environmentally friendly and involves relatively toxic chemicals like HCl and sodium hydroxide with different percentage. Hence, eco- friendly biological and microbial techniques for the preparation of chitin and chitosan from prawn shells are the dire need in order to prevent further environmental problems [12,13].

The results of the present study showed that the prawn species having the highest concentration value of chitosan (g) and the prawn species having the highest percentage value of chitosan is not the same species. The resulted yield chitosan is relatively depended on the extracted amount of chitin from the prawn shells ie., yield chitin.

4. Conclusion

Prawn industries are efficiently substantial in promoting a great deal to foreign exchange. Bio hazardous prawn shell waste can be converted into useable products which are not financially valuable but also helps in diminishing pollution, risk of potential pathogens infection, etc. Many biochemists have found that chitosan as biocompatible, biodegradable which made wide applicability in pharmaceutics especially suitable for the pharmaceutical industry in designing delayed and controlled drug delivery system. Purified qualities of chitosan are available for biomedicine applications such in bone pain, burns, anti-tumors, AIDS inhibitors. Pharmaceutical industry is in need of different types of chitosan presently available in the market which are to be precise further more to meet the obligatory quality. Chitosan augment the transport of polar drugs across epithelial surface. Chitosan scaffolds are propitious materials for the design of tissue engineered system. Chitosan serves as a raw material for toothpaste as it helps in reducing dentin penetration. To elevate the expansion of chitosan industry to proficient boundary extensive research in their usage and marketing of products are important.

Chitin and its derivatives can be used in the textile industry to produce synthetic fibers, coatings and auxiliary fabrics. These biopolymers display a wide range of unique applications as an addictive in bioconversion processing to produce value added food products. The use of chitosan in the food industry is related to its functional properties and nutritional and physiological activities. The use of low-cost polymers such as chitin and chitosan to remove water pollutants is of great significance. Chitosan can be used in agricultural industry as plant protection which has two roles as a biopesticide and fertilizers enhancement. The chelating feature of the polymer encourages the formulators to use it as a delivering nitrogen, phosphorous and potassium.

It is necessary to conduct research project on practical applications such as the combination of chitin and chitosan in nanomaterials, nutraceutical products and NACOS and COS. Recycling shellfish waste and purifying commercially useable substances like chitin or chitosan with multiple bio-medical applications are prominent at the urgent. Additionally, it is significant because it can educate the public about the potential utilize of waste and can provide new business opportunities for the community by recycling it into a new exceptional product.

References

[1] Chaudhuri, S., Economic Zoology (Kolkata: New Central Book Agency (P) Ltd., 2017).
[2] Naik, B. V., Patil, S. V., Shirdhankar, M. M., Yadav, B. M., Tibile, R. M., Wasave, S. M., and Yewale, K. C. V., 'Shrimp Farming Sector in South Konkan Region, Maharashtra: A Constraint Analysis', Journal of Entomology and Zoology Studies, 8.5 (2020), 356-359.
[3] Zia, Z. M., and Sheriff, M. A., 'Experiment on the Chemical Extraction of Chitin and Chitosan from the Exoskeletons of Indigenous Prawn Species and Their Biomedical Application', International Journal of Zoology and Applied Biosciences, 4.3 (2019), 106-112.
[4] Tan, H. W., Lim, Z. Y. J., Muhamad, N. A., and Liew, F. F., 'Potential Economic Value of Chitin and Its Derivatives as Major Biomaterials of Seafood Waste, with Particular Reference to Southeast Asia', Journal of Renewable Materials, 10.4 (2022), 909.
[5] Aranaz, I., Mengíbar, M., Harris, R., Paños, I., Miralles, B., Acosta, N., et al., 'Functional Characterization of Chitin and Chitosan', Current Chemical Biology, 3.2 (2009), 203-230.
[6] Rashmi, S. H., Biradar, B., Maladkar, K., and Kittur, A. A., 'Extraction of Chitin from Prawn Shell and Preparation of Chitosan', Research Journal of Chemical and Environmental Sciences, 4 (2016), 70-73.
[7] Puvvada, Y. S., Vankayalapati, S., and Sukhavasi, S., 'Extraction of Chitin and Chitosan from the Exoskeleton of Shrimp for Application in the Pharmaceutical Industry', International Current Pharmaceutical Journal, 1.9 (2012), 258-263.
[8] Khaled, A. M., 'A Review on Natural Biodegradable Materials: Chitin and Chitosan', Chemistry Advances in Materials, 6.1 (2021), 1-5.
[9] Beaney, P., Lizardi-Mendoza, J., and Healy, M., 'Comparison of Chitins Produced by Chemical and Bioprocessing Methods', Journal of Chemical Technology and Biotechnology: International Research in Process, Environmental and Clean Technology, 80.2 (2005), 145-150.
[10] Kamala, K., Sivaperumal, P., and Rajaram, R., 'Extraction and Characterization of Water-Soluble Chitosan from Parapeneopsis stylifera Shrimp Shell Waste and Its Antibacterial Activity', International Journal of Scientific and Research Publications, 3.4 (2013), 1-4.
[11] Paul, S., Jayan, A., Sasikumar, C. S., and Cherian, S. M., 'Extraction and Purification of Chitosan from Chitin Isolated from Sea Prawn Fenneropenaeus indicus', Extraction, 7.4 (2014), 201-204.
[12] Arbia, W., Arbia, L., Adour, L., and Amrane, A., 'Chitin Extraction from Crustacean Shells Using Biological Methods – A Review', Food Technology and Biotechnology, 51.1 (2013), 12-25.
[13] Xie, W., Xu, P., and Liu, Q., 'Antioxidant Activity of Water-Soluble Chitosan Derivatives', Bioorganic and Medicinal Chemistry Letters, 11 (2001), 1699-1701.

Author Profile

Priyanka Thounaojam is a dedicated Master's student in Zoology (M.Sc. Zoology), with a deep passion for understanding the animal kingdom and life sciences. Her academic journey highlights a keen interest in wildlife conservation, ecology, and animal behavior. Recognized for her research aptitude, analytical skills, and attention to detail, Priyanka actively participates in state and national co-curricular activities, earning accolades for her contributions. Driven by a strong work ethic and enthusiasm for scientific exploration, she aims to make a significant impact in zoology. With her commitment to academic growth and groundbreaking research, Priyanka is on track to become a promising researcher in the field of zoology.

Dr. Mujeeb Shaikh is the Head of the Department of Zoology at AKI's Poona College of Arts, Science and Commerce, Pune. He holds an M.Sc. in Zoology (Specialization in Fisheries Science) and a Ph.D. from the Marine Research Laboratory, Ratnagiri. With 19 years of teaching experience and 19 years of research expertise, He is highly regarded in his field. He has received the Best Teacher Award from EMPCTFEAK, Jaipur, and has published 16 research papers, one patent, three books, and two book chapters. A recognized Ph.D. guide at Savitribai Phule Pune University, he has presented papers at various national and international conferences. He has organized both national and international conferences and serves on the BoS for Zoology at Abeda Inamdar Senior College, Pune. He is also a life member of the Indian Science Congress Association. Association (ISCA).