SYNTHESIS AND CHARACTERIZATION OF CHITIN NANOPARTICLES EXTRACTED FROM THE WASTE OF SHRIMP SHELLS

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ABSTRACT:

Shrimp shell waste is used in this work to produce chitin. This is a cost-effective and sustainable approach for synthesizing chitin nanoparticles. This technique enables versatility in the synthesis of chitin nanoparticles with controlled morphologies, sizes, and properties for a range of uses in food packaging, environmental remediation, tissue engineering, and drug delivery. Shell powder is demineralized using 1% hydrochloric acid and deproteinized with 1M sodium hydroxide, respectively. X-ray diffraction was used to characterize the generated chitin. Chitin was identified as the prepared nanoparticle by XRD. The chitin nanoparticle's high crystalline nature is indicated from the lack of impurity peaks. Using the Debye-Scherrer formula, the particle size is determined to be 41 nm.

Keywords: Synthesis and Characterization, Shrimp shell, Chitin nanoparticles.

INTRODUCTION:

Chitin:

Chitin is a copolymer of poly (ß-(1-4)-N-acetyl-D-2-glucosamine) and poly (ß-(1-4)-D-2- glucosamine) repeating units. It is a colourless, odourless, tasteless, nitrogenous polysaccharide found in the outer skeleton of insects, crabs, shrimps and lobsters and fungi. It is the most abundant amino polysaccharide and most abundant polysaccharide in the earth. Annually 1010 -1012 tons of chitin are produced by biosynthesis.Chitin adopts three different types of structural arrangement, α-, β- and γ-types which differ in their degree of hydration, number of hydrogen bonds, size of the unit cell, and number of chitin chains per unit cell. The α-type is the most robust form among the three,with an antiparallel arrangement of chitin chains and extensive intra and intermolecular hydrogen bonds. The αtype of chitin is the most abundant form of chitin in the nature and is found in exoskeletons of shellfish and fungal cell

walls, and is more resistant towards physical and chemical changes. In contrast, β-chitin is more mobile with a parallel arrangement of chitin chains; in this case, N - acetyl groups act as spacers between the chains which results in weaker intermolecular interactions, allowing easier access to solvent molecules. β-allomorph of chitin is mainly found in diatoms and squid pens. The γ-type is the combination of the both, found in Loligo squid and cuttlefish stomach lining.

Sources of chitin:

Chitin occurs in fungi, diatoms, nematodes, arthropods, plants, insects and animals. It is also found in various terrestrial sources such as mosquitoes, cockroaches, honeybees, silkworms, drosophila melanogaster (fruit fly), extatosoma tiaratum (spiny leaf insect) and sipyloidea sipylus (pink winged stick insect). The composition of the chitin varies depending on the species. Commercial production of chitin is limited to few marine organisms such as prawn, shrimp, crab, lobster, krill and squid pen due to their greater availability as waste from seafood processing industry. Approximately 45-weight percentage of crustaceans are discarded as waste during food processing stage. This discard includes head, shell, thorax, and claws which are predominant in chitin, protein, and minerals. [1]

Shrimp shell:

Shrimp shells consist mainly of chitin, protein and minerals. About 20 to 30 per cent of a shrimp shell is made up of chitin. They are a potential source of calcium. Analyses showed that the shrimp shell consisted of 18.1% chitin, 33.3% $CaCO_3$, and 38.6% protein.

MATERIALS AND METHODS:

2 Kg of shrimp are bought from the local market of Thoothukudi and the shells alone where removed completely. Wash the shells thoroughly with double distilled water. Then it is dried in hot air oven for 30 hours at 800℃. The dried shells were grinded into powder and stored in a closed container in freezer until it is used. 30 g of shell powder is mixed with 1M of NaOH with solid to solvent ratio 1:5. This solution is kept undisturbed for 24 hours at room temperature. Then the residue is washed and soaked in double distilled water for several times. Further it is dried in

oven at 600°C. The dried powder is then treated with 1% of HCl with solid to solvent ratio 1:5 and kept undisturbed at room temperature. Then the residue is washed and soaked in distilled water until the pH reached neutral. Next it is kept in oven at 60◦C until it is dried. The dried sample is placed in muffle furnace at 750º C. The precipitate thus obtained is finely powered. The produced residue is known as chitin.

RESULT AND DISCUSSION:

Characterization using XRD:

The structural characterization of the chitin is carried out by the XRD method. The x-ray diffraction

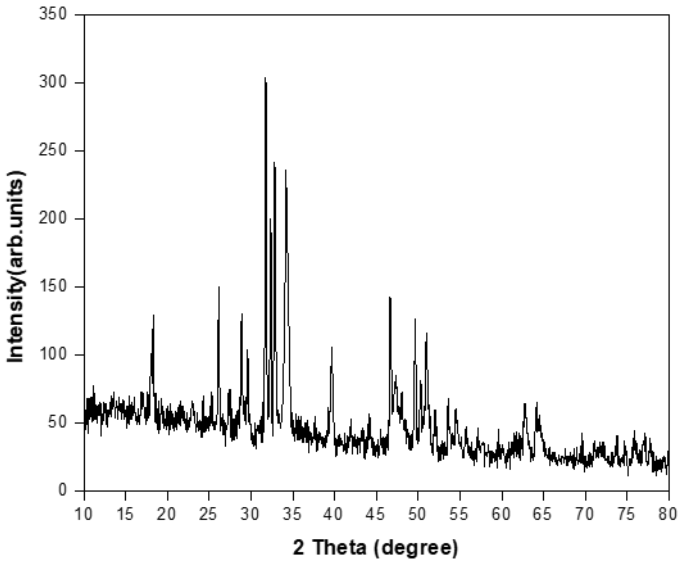
experiments are carried out with the XPERTPRO diffraction system using the CuKα radiation of wavelength 1.5406A°. The type of the scan used is continuous and range from 10° to 80°. The average grain size is calculated using the Debye Scherrer formula,

$$D=K\lambda/\beta\cos\theta \text{ (m)}$$

λ - X-ray wavelength

β- line broadening at half the maximum intensity (FWHM)

θ- Bragg angle



XRD pattern of Chitin

The XRD results for the Chitin nanoparticles exhibit strong peaks around 2θ =18.17° and 2θ =26.14° belongs to alpha chitin. The peaks values are in good agreement with the JCPDS cards. The absence of impurity peaks denotes the highcrystalline nature of the composite material. The average crystalline size of the particle is 41nm which is calculated using Debye Scherrer formula.

CONCLUSION

As a novel product of the acid hydrolysis of chitin, Chitin nanoparticles exists in α-chitin with more less-ordered domains than native chitin. In this present investigation, chitin is synthesized using the waste of shrimp shells. This is one of the eco-friendly cost effective method to synthesis Chitin nanoparticles. This method offers versatility in synthesizing chitin nanoparticles with controlled sizes, morphologies, and properties for various applications in drug delivery, tissue engineering, food packaging, and environmental remediation. The choice of synthesis method depends on factors such as desired nanoparticle properties, scalability, cost-effectiveness, and environmental considerations. From XRD pattern of as prepared Chitin, it is well noted that the peak values are in good agreement with previous reported work. The particle size is calculated using Debye Scherrer formula which is 41nm.

REFERENCES:

[1]. Dhamodharan. R, Devi. R, Seperation of Chitin from crustacean shell waste and the preparation of nanocrystals of Chitin and Cellulose, (2019).