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Chitin Extraction and Synthesis of Chitin-Based Polymer Films from Philippine Blue Swimming Crab (*Portunus pelagicus*) Shells

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Abstract

Chitin has been extracted from Philippine blue swimming crab. The extracted chitin was subjected to thermo gravimetric analysis (TGA), Fourier transform infrared (FTIR) spectroscopy and X-ray diffraction (XRD) analysis The degree of acetylation of the extracted chitin, derived from the X-ray diffraction intensity values of chitin characteristic peaks, revealed that the extracted chitin is purer than the commercially acquired high purity chitin. The extracted chitin was used to form polymer films at different formation conditions. Polymer films were also formed from commercially acquired chitin for comparison. It was shown that films prepared from the extracted chitin at different conditions have greater ultimate tensile strengths as compared to the commercially-available plastic film. Morphologies of the material surface and the fracture surface were investigated using the scanning electron microscope to identify stress concentration sites that contributed to the weakening of material under tensile loading.

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Keywords: Chitin, Blue swimming crab, Polymer films

1. Introduction

Chitin, also known as poly(β-(1→4)–N-acetyl-D-glucosamine, is the second most abundant biopolymer in nature, next to cellulose. It is described as colorless, crystalline or amorphous powder, which is insoluble in water, organic solvents and diluted acid and alkali [1].

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It exists in nature in the exoskeleton of crustaceans and arthropods or in the cell walls of fungi and yeast [2]. But the primary source of chitin is the marine crustacean shell waste from shrimp, prawns and crabs [3]. These crustaceans are estimated to have maximum chitin content of 15 to 20 percent, along with proteins and calcium carbonate [1].

Large amount of chitin is being synthesized worldwide. The total annual production of chitin by arthropods had been estimated at 1, 328,000,000 MT from marine ecosystem, 28,000,000 MT from freshwater ecosystem, and 6,000,000 MT from athalassohaline ecosystem [4]. In the end, the major concern in chitin production is not the source but the final product's quality [5] which depends on the extraction process.

In the Philippines, significant amount of marine and agricultural shells become waste by-products from the food industry, among them is the blue swimming crab (*Portunus pelagicus*) shells. For the year 2011, 29,000 MT of blue swimming crab was captured [6]. The figure corresponds to 1.34% or fourth from the largest of the total fishery capture of the Philippines. In terms of global production, 185,000 MT of blue swimming crab was processed based on the Food and Agriculture Organization of the United Nations.

Several processes have been employed in the extraction of chitin from arthropods. Shimahara & Takiguchi [7] classified the isolation of chitin into two different procedures, the biological extraction and the chemical extraction of chitin. But both of these procedures follow the same stages in chitin isolation; the demineralization stage and the deproteinization stage of chitin extraction. The chemical extraction method, however, yields into higher percent purity chitin as compared to biological extraction [3,8-12].

Both chitin and the chitin-derived chitosan have wide ranging applications in the field of biomedicine, materials science, microbiology, tissue engineering, food technology, agriculture, electrochemical technology, environmental technology, textile, energy and bio-nanotechnology. Chitin's purity is taken into account to suit the different needs of various applications, e.g. chitin for biomedical application requires higher percent purity to avoid contamination. Recently, the Wyss Institute was able to form bioplastic from chitosan derived from shrimp shells [13].

It is, therefore, the objective of this study to extract chitin from Philippine blue swimming crab shells. Moreover, the extracted chitin was formed into polymer films. Both the extracted chitin and synthesized film had been subjected to various characterization tests.

2. Methodology

2.1. Chitin Extraction

The general procedure established by Shimahara & Takiguchi[7] and the acid concentration, particle size, reaction time, temperature and stirring rate from the results of Chang et al.[16] have been used in the extraction of chitin. The product from the extraction process was subjected to various characterizations to determine composition, degree of acetylation (DA), and thermal stability while comparing with the commercially acquired chitin. Particularly, the DA is indicative of the purity of chitin wherein high values would correspond to a high purity material. The extracted chitin has a computed DA of 68.16 % and the commercially available chitin with only 30.99 %.

$$I_{CR} = \frac{I_{020} - I_{am}}{I_{020}} \; x \; 100 \tag{1}$$

$$DA = 100 - \left(\frac{103.97 - I_{CR}}{0.7529}\right) \tag{2}$$

Where:

I_{CR} - crystalline index
I_{020} - intensity of the peak at (020) at $2\theta < 13°$
I_{am} - intensity of peak at $2\theta \cong 28°$