Isolation and Characterization of Chitin Nanowhiskers from Fermented Tiger Prawn Waste

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The objective of this study is to produce chitin nanowhiskers (CNW) from bacterial fermentation of tiger prawn waste. For this purpose, chitin was first extracted from tiger prawn waste using bacterial fermentation process followed by isolation of CNW using acid hydrolysis process. The isolated CNW from fermented tiger prawn waste (FCNW) were investigated using Fourier transform infrared (FTIR) spectroscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), x-ray diffractometer (X-RD) and thermogravimetric analysis (TGA). FTIR spectra analysis indicates that the acid hydrolysis of chitin did not altered the chemical structure of isolated FCNW. TEM analysis revealed that the produced FCNW displayed a nanoscale structure with an average length and width of 100 and 10 nm. AFM images of FCNW indicate the presence of spindle-like features. The X-RD analysis revealed that the acid hydrolysis process enhanced the crystallinity of FCNW from 20 to 46 % compared to chitin due to the removal of the amorphous region. The TGA results revealed that the FCNW is more thermally stable than fermented chitin (FC) and CNW from commercial chitin. The relatively good thermal stability of FCNW shows its suitability in a range of applications such as reinforcing fillers in green nanocomposites.

1. Introduction

For many years, chitin a natural polysaccharide having a linear polymer chain of N-acetyl-D-glucosamine linked by \( \alpha (1, 4) \) glycosidic bond is popular among researchers due to its cheap and abundant availability worldwide. Chitin polymeric chains exists in \( \alpha \)-crystalline form in exoskeleton of crustaceans such as crab, shrimp and lobster while \( \beta \)-chitin can be found in squid pens (Chaussard and Domard, 2004). Interestingly, in the last decade new interest in the use of chitin for nanocomposite materials has emerged because chitin is found to have desirable mechanical property due to their natural stacks of chitin nanocrystals embedded within the amorphous region. The amorphous region however can be removed through acid hydrolysis process. The remaining crystalline region normally exist in nanoscales can be further used as a reinforcing nanofillers for the development of green nanocomposites (Kelnar et al., 2015). Various methods have been employed in the production of chitin nanowhiskers including acid hydrolysis (Nair and Dufresne, 2003), TEMPO-mediated oxidation (Fan et al., 2012), and mechanical treatment (Fan et al., 2012).

Chitin is commercially obtained through harsh chemical treatments using acids and alkalis (Chandumpai et al., 2004) which discard large amount of chemical wastes that leads to environmental pollution. An alternative approach using biological processes (bacterial fermentation) to purify chitin from crustacean waste has also been reported which provides an environmentally cleaner approach and cheaper production cost (Zakaria et al., 1998). Besides chitin, this method also produces protein rich liquor which is suitable as protein source in aquaculture feed (Nor et al., 2011). Finding application for the by-product chitin would be an economical advantage to the frozen prawn processing industries which normally discard nearly 50 % of the whole...