A Green Approach to Synthesize Chitosan Nanoparticles from Shrimp Exoskeleton: Basis to Develop Control Release Nanofertilizer

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Abstract

Synthesis of nano-particles has become a matter of great interest in recent years due to their so many functional properties and applications in a variety of fields. Nano-particle mediated control release fertilizer is one of the applications which has potential to enhance plant growth and yield while minimizing serious environmental impacts due to excessive use of conventional bulk fertilizers. Nevertheless, many of the research work carried out in relation to synthesis of nanoparticles have used synthetic constituents which are being considered as harmful to the human health and environment. Investigations have also indicated that certain engineered nanomaterials can lead to unforeseen health and environmental risks. The aim of the present study was to produce biodegradable and biocompatible nanoparticles in an eco-friendly manner originated from locally available raw materials and natural excipients addressing the said risks which will ultimately lead to development of eco-friendly nanofertilizers to release nutrients gradually in a controlled manner. Chitosan, a natural biocompatible and biodegradable polymer, was synthesized from chitin which was extracted from exoskeleton of black tiger shrimp (*Penaeus monodon* Linn) and blue swimming crab (*Portunus pelagicus* Linn). Chitosan nano-particles were synthesized using tripolyphosphate with ionotropicgelation method. Chitosan microspheres were obtained using exudate of *Acacia auriculiformis* Linn and lime extract (fruit of *Citrus aurantifolia* Linn) as the cross linking agents. Fourier Transform Infra-Red (FTIR) spectroscopic analysis confirmed structure of the synthesized chitosan against standard chitosan. Average size of the synthesized chitosan nano-particles is 90 nm (figure 1) which can be tuned by controlling the pH, dose of the cross linker and concentration. Results of this study will pave pathway to achieve green nano-partciles.

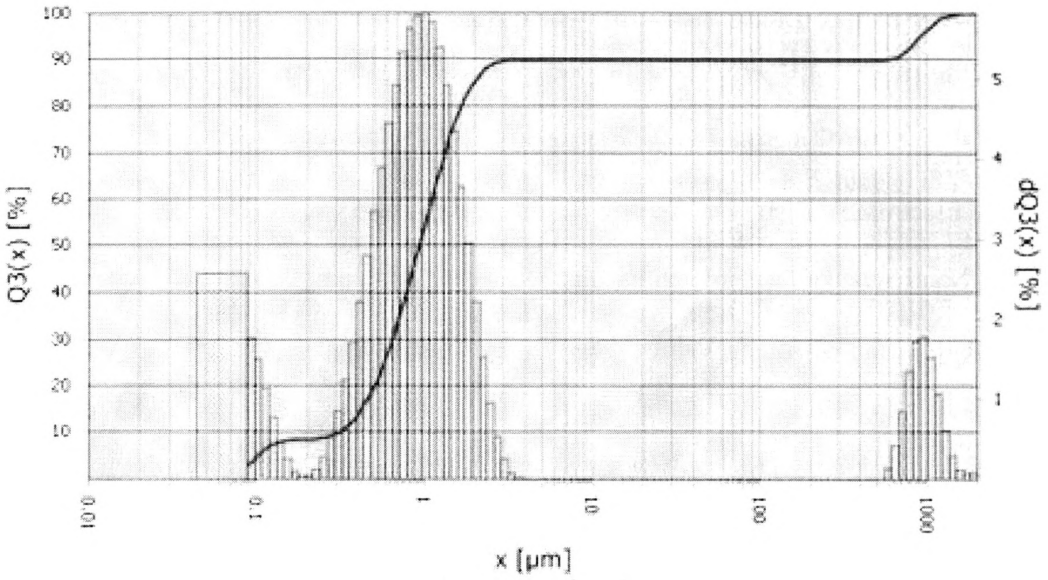

Figure 1. Particle size distribution of chitosan nano-particles obtained with Tripolyphosphate at concentration level of 1 mg/ml at pH 5.

Keywords: Biocompatible; Chitosan; Ionotropicgelation; Nanoparticles; Natural polymer

Characterization of Double Layer Supercapacitor Based on Locally Developed Activated Carbon/polytetrafluoroethylene Electrode in High Concentrated Aqueous Electrolyte

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Abstract

The global energy consumption is accelerating while alarming that current fossil fuel resources are depleting rapidly. Hence, sustainable, renewable and environmental friendly technologies for energy generation and storage are considered essential to fulfil current energy demand while protecting the environment. For past few decades, more effective and efficient energy storage mechanisms were toughly studied. Among them, supercapacitors were able to capture great attention due to is high applicability as energy storage device in electric vehicles, hybrid vehicles and portable electronics devices. This research was focused on developing a novel supercapacitor based on locally developed activated carbon and polytetrafluoroethylene (PTFE).

Electrodes plays a key role defining the capacitance of the supercapacitor. As a result, research to improve its performance has been dramatically increased. Electrode material for double layer supercapacitors are generally carbonaceous materials such as activated carbon, mesoporous carbon, carbon nanotubes and graphene. In pseudo-supercapacitors electrode materials are transition metal oxide and conducting polymers. This research was focused to fabricate a supercapacitor which uses locally activated carbon with PTFE as its electrodes. Coconut shell charcoal was used to make activated carbon since its high availability with the region. In this study, high concentrated potassium hydroxide (5M) was used as a novel approach while reported literature was based on low concentrated potassium hydroxide .

Coconut shells were selected in a way that average size of a pieces of shells were nearly 4×4 cm. They were well cleaned by washing with de-ionized water several times. Afterwards, they were slowly burnt in air to obtain charcoal. Thereafter, freshly prepared charcoal was places in a sealed container to avoid absorption of water vapour until its temperature turned down to room temperature. Flow of steam was applied to the cooled charcoal afterwards and let it activate with steam for about 2 hours. It was vacuumed to get rid of the water vapours with the charcoal in the

container. Once more, it was kept in the same chamber until its cooled down to room temperature. Finally, charcoal was ground with Fritch Premium Line ball mill and the partial size was measured with Fritch Nano-Tech Plus 22 particle size analyzer. The particle size was found to be 3 μm in average.

The weight of electrode was 20 mg. Electrode consists of 90% of activated carbon and 10% of Polytetrafluoroethylene (PTFE) which was analytical grade (purity>99.8). Activated carbon, PTFE and KOH was mixed until homogenous paste obtained. The paste was spread out on the stainless steel sheet (2 cm × 2cm) which worked as the current collector. After that, it was dried at 45 ^{0}C for 1 hour in the muffle oven. Similarly, Pair of electrodes were fabricated. The supercapacitor was prepared by immersing a separator in a 5 M KOH solution and sandwiched in between the pair of electrodes in the test cell.

Cyclic Voltammetry (CV), Charge Discharge and Electrochemical Impedance Spectroscopy (EIS) was carried out to study electrochemical performance of the supercapacitors by using Metrohm Autolab PGSTAT128. CV measurements were performed at the scan rates 2.5, 5, 7.5 10, 12.5, 15, 20, 30, 50, 100,150 and 200 mV/s. Voltage window was selected from -0.5 to 0.5V with two electrodes configuration. Using the CVs, the specific capacitances were calculated for each scan rates respectively. It is well known that, for supercapacitor application, capacitance and equivalent series resistance are two important parameters that can influence the performance of the supercapacitor such as power density and energy density. Charge- Discharge measurements were carried out at 500 μA constant current. CV curves were showed no obvious redox peaks and the current is nearly constant over most of the voltage window, which indicates that the supercapacitors are charge - discharge mainly by electrostatically. Moreover, the CV curves were showed a nearly rectangular shape. However, upon increasing the scan rate, this capacitance behavior was destroyed. Specific capacitance 79 F/g was obtained as highest value for scan rate 2.5 mV/s. In EIS plot (Nyquist plot), there was semi-circle intersecting the real axis in high frequency and the slope of tail on Nyquist plot was almost parallel to the imaginary axis, which suggest that the fabricated capacitor show an actual capacitor behavior. The equivalent serial resistance of 55.24 Ω was calculated by using charge– discharge curve. It was found that the specific power density was 69 W/kg, and Specific Energy density was 5.8 Wh/kg.

Keywords: Activated carbon; Electrolyte; Specific capacitance; Supercapacitor