Chapter 14
Characteristics of Chitosan Nanoparticles for Water and Wastewater Treatment:
Chitosan for Water Treatment

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ABSTRACT

Chitosan is a naturally occurring biopolymer originating from several microbial species as well as crustacean species, such as shrimp and lobster. Chitosan has excellent physical and chemical properties that allow its use in various environmental applications especially in water treatment. It is a biodegradable polymer, and it is inexpensive providing an environmentally friendly and economic option for water and wastewater treatment. Chitosan offers a myriad of applications through chemical coagulation and flocculation, antimicrobial properties, adsorption capabilities, and nanofiltration and can provide a sustainable route for water and wastewater treatment. This book chapter elaborates the recent developments in chitosan applications in water and wastewater treatment.

INTRODUCTION

Water---an innate right---is somehow squandered even in the 21st century. Approximately 10,000 people die as a result of inadequate water supply and related third-world issues every day (UNwater, 2015). Currently, civilizations are growing at twice the rate of the availability of water resources, and it is projected that up to 1.8 billion people will experience absolute water scarcity by 2025 (UNwater, 2015). The importance of economical, clean water cannot be overstated in a society facing environmental issues such as pollution of water resources, droughts, and increasingly dwindling freshwater availability.

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Fortunately, modern day science might have the answer in a naturally occurring polymer: chitosan. Chitosan is simply derived by the deacetylation of shellfish exoskeletons. Chitin can also be found in fungi, cell walls, and yeast. Although small, this nanoparticle continues to substantially impact water treatment through its idealistic properties, diverse applications, and economical potential. These diverse applications of chitosan include coagulation and flocculation for water and wastewater treatment, antimicrobial properties, adsorption capabilities of dyes and heavy metals, and desalination through nanofiltration. Many physical and biological properties of chitosan produce a linear polysaccharide ideal for water and wastewater treatment applications.

CHITOSAN PROPERTIES AND PREPARATION

Chitin, as shown in Figure 1, is the acetylated precursor to chitosan. The removal of these acetyl functional groups allows for higher solubility due to the increase in positive charge. Due to its deacetylation, chitosan is considered a pseudo-natural biopolymer which is predominantly characterized by its degree of deacetylation (DD) and molecular weight (MW). Considering that these two properties are directly proportional, the degree of solubility can be seen as inversely proportionate to the MW and directly proportionate to the DD. The degree of deacetylation is a molar percentage which differentiates chitin from chitosan at precisely 50% mol. This 50% DD allows for solubility in acidic aqueous solutions.

Acetylated Chitosan, or Chitin, is known to exist in two allomorphs, α and β. The more abundant α Chitin is found within traditional yeast, fungi, shrimp, crab, krill, lobster, and crawfish. The less abundant β Chitin is found within the protein in squid pens and is not an industrial source. Beyond knowledge of

Figure 1. Chitin, chitosan, cellulose (Alvarenga, 2011)