CHAPTER VII
CONCLUSIONS AND RECOMENDATIONS

Chitin-chitosan is well known as one of the most important marine polysaccharides. It shows not only biodegradability and biocompatibility, but also bioactivity, especially antimicrobial activity, thus, the applications in the field of biomedicines and biotechnology is expected. However, up to present, most applications in chitosan are based on the value-added products by mean of physical and chemical modifications. When we consider the uses of plastics in biomedical field, especially, the commodity ones, i.e., PE, PP, bio-additives are always needed for the sterilization treatment to ensure the products from microbes or germ contamination. On this view point, applying chitosan as a bio-additive is a good way to extend the value-addition onto chitosan. The present work, thus, demonstrates how we can develop chitosan as bio-additives for commodity polymer.

The first part (Chapter III) deals with the surface modification of commodity polymer, i.e. polyethylene, with bio-additive chitosan to achieve a new value-added product based on the specific properties of chitosan. Since chitosan exhibits the unique properties as mentioned, the use of chitosan as a bio-additive for surface functionalization would give new functions to that of polymer substrate. The present work showed a practical pathway to introduce chitosan onto PE surface by γ-irradiation. Chitosan-HOBt aqueous solution was applied as a simple and effective system for functionalizing chitosan onto PE film. The radiation dose of 80 kGy was found to be an optimum condition to achieve the highest amount of chitosan on PE. Copper ion adsorption ability of PE-*graft*-chitosan was also carried out to propose chitosan-Cu^{2+} chelating material. The PE film with chitosan on the surface and copper ion covered on the chitosan via chelation may be a practical insecticide or pesticide material as well as a toxic heavy metal adsorptive material for the future.

The second part (Chapter IV, V, and VI) focused on the chemical modification of chitosan as a bio-additive based antioxidant for compounding with commodity polymer. Chitosan was conjugated with gallic acid (GA) to obtain chitosan-GA. It was found that by introducing gallic acid onto chitosan chain, the product showed water swelling and antioxidant properties due to the hydrophilic bulky group and H-atom donation ability of galloyl group, respectively. The present work also showed how chitosan water solubility was improved after conjugating gallic acid.

Antioxidant activity of chitosan-GA was also studied. A variety of electron paramagnetic resonance techniques (Chapter V) was used to clarify the antioxidant potential of chitosan derivative. The comparative studies of GA and chitosan-GA confirmed that the galloyl group on chitosan effectively transferred H-atom and subsequently formed stable semiquinone radicals resulting in a wide range of antioxidation activity of chitosan-GA with oxidizing free radicals, such as 1,1-diphenyl-2-picryl-hydrazyl (DPPH), carbon-centered, peroxyl, and hydroxyl radicals.

Based on the successful development of chitosan antioxidant, the work was further extended to prepare the bio-additive antioxidant for commodity polymer compounding. Chapter VI showed the conjugation of deoxycholic acid (DC) as the hydrophobic group onto chitosan-GA to improve compatibility with commodity polymers. The product (chitosan-CD-GA) is a good model of green antioxidant for commodity polymer, especially for the products to be used in biomedical applications of which the sterilization by electron beam or γ-radiation. The further works to be done are such as (i) the confirmation in the compatibility between chitosan-CD-GA and commodity polymer, i.e. polyethylene and (ii) the antioxidant potential of chitosan-DC-GA derivative after compounding with polyethylene