World Academy of Science, Engineering and Technology
International Journal of Electrical and Computer Engineering
Vol:10, No:01, 2016

Biomedical Application of Green Biosynthesis Magnetic Iron Oxide (Fe3O4) Nanoparticles Using Seaweed (Sargassum muticum) Aqueous Extract

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Abstract : In the field of nanotechnology, the use of various biological units instead of toxic chemicals for the reduction and stabilization of nanoparticles, has received extensive attention. This use of biological entities to create nanoparticles has designated as “Green” synthesis and it is considered to be far more beneficial due to being economical, eco-friendly and applicable for large-scale synthesis as it operates on low pressure, less input of energy and low temperatures. The lack of toxic byproducts and consequent decrease in degradation of the product renders this technique more preferable over physical and classical chemical methods. The variety of biomass having reduction properties to produce nanoparticles makes them an ideal candidate for fabrication. Metal oxide nanoparticles have been said to represent a "fundamental cornerstone of nanoscience and nanotechnology" due to their variety of properties and potential applications. However, this also provides evidence of the fact that metal oxides include many diverse types of nanoparticles with large differences in chemical composition and behaviour. In this study, iron oxide nanoparticles (Fe3O4-NPs) were synthesized using a rapid, single step and completely green biosynthetic method by reduction of ferric chloride solution with brown seaweed (Sargassum muticum) water extract containing polysaccharides as a main factor which acts as reducing agent and efficient stabilizer. Antimicrobial activity against six microorganisms was tested using well diffusion method. The resulting S-IONPs are crystalline in nature, with a cubic shape. The average particle diameter, as determined by TEM, was found to be 18.01 nm. The S-IONPs were efficiently inhibited the growth of Listeria monocytogenes, Escherichia coli and Candida species. Our favorable results suggest that S-IONPs could be a promising candidate for development of future antimicrobial therapies. The nature of biosynthesis and the therapeutic potential by S-IONPs could pave the way for further research on design of green synthesis therapeutic agents, particularly nanomedicine, to deal with treatment of infections. Further studies are needed to fully characterize the toxicity and the mechanisms involved with the antimicrobial activity of these particles. Antioxidant activity of S-IONPs synthesized by green method was measured by ABTS (2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid) (IC50= 1000µg) radical scavenging activity. Also, with the increasing concentration of S-IONPs, catalase gene expression compared to control gene GAPDH increased. For anti-angiogenesis study the Ross fertilized eggs were divided into four groups; the control and three experimental groups. The gelatin sponges containing albumin were placed on the chorioalantoic membrane and soaked with different concentrations of S-IONPs. All the cases were photographed using a photo stereomicroscope. The number and the lengths of the vessels were measured using Image J software. The crown rump (CR) and weight of the embryo were also recorded. According to the data analysis, the number and length of the blood vessels, as well as the CR and weight of the embryos reduced significantly compared to the control ($p < 0.05$), dose dependently. The total hemoglobin was quantified as an indicator of the blood vessel formation, and in the treated samples decreased, which showed its inhibitory effect on angiogenesis.

Keywords : anti-angiogenesis, antimicrobial, antioxidant, biosynthesis, iron oxide (fe3o4) nanoparticles, sargassum muticum, seaweed
Conference Title : ICMNT 2016 : International Conference on Micro and Nano Technology
Conference Location : Singapore, Singapore
Conference Dates : January 07-08, 2016