CONTROLLED GREEN SYNTHESIS OF SILVER NANOPARTICLES USING LOCALLY AVAILABLE PLANTS FOR IN-SITU

This thesis focuses on controlled green synthesis of silver nanoparticles and on development of durable treatment of green silver nanoparticles on cotton fabrics. Locally available plants (*Azadirachtaindica, Murryakoenigii, Ocimum sanctum, Carica papaya, Eucalyptus hybrida* and *Chenopodium album*) that were abundantly available; were screened for synthesis of silver nanoparticles (SNP)so that the scale up becomes possible.The parameters tested for selection of leaf extract were uniformity in size and shape of SNP, yield and stability. The leaf extract of *Azadirachtaindica* was seen to be the most efficient in SNP synthesis with respect to the tested parameters. Further, in order to improve the efficacy of *Azadirachtaindica*leaf extract for SNP synthesis, optimization of synthesis parameters was carried out and monodisperse and stable SNP were synthesized under the optimized conditions.

Carica papaya leaves were used for the synthesis of silver nanoparticles (Pa-SNPs). The parameters such as temperature and pH were optimized for increasing the production yield of SNPs with size ranging from 10- 70 nm. The antimicrobial activity of the Pa-SNPs along with few antibiotics (penicillin, kanamycin and chloramphenicol) was evaluated against *E. coli and S. aureus*. A synergistic effect was observed with SNPs combined with antibiotics in Zone of inhibition assay.. In the dye degradation assay, ability of Pa-SNPs was studied for Blue CP and Yellow 3RS, the results showed effective degradation ability of Pa-SNPs with 90% and 83 % removal forBlue CP and Yellow 3RS, respectively at 50 mg/l of dye concentration.

Hypothesis was developed regarding the kinetics of formation of SNP during green synthesis by use of bio-extracts as reducing agent. The hypothesis was developed on the basis of morphology of SNP reported under different synthesis conditions.Spherical silver nanoparticles of required size were synthesized employing a seed-mediated approach using leaf extract of *Azadirachtaindica*. Reaction pH was used to manipulate the rate of reduction of the precursor salt from a fast rate of reaction needed during synthesis of silver nanoparticles seeds and a slower rate of reaction needed for controlled growth and inhibition of secondary nucleation. A mathematical model was developed for staggered growth of silver nanoparticles using a multi-step growth approach. The developed model was used to predict the size of silver nanoparticles after various growth steps and was compared with the experimentally achieved results.

Cotton fabrics were coated with silver nanoparticles by an environment friendly method using in situ reduction of silver nitrate with leaf extract of *Azadirachtaindica*. For improving the wash durability of silver nanoparticle coating, mercerization of cotton fabrics was used as a pre-treatment followed by in-situ synthesis of nanoparticles under hydrothermal conditions of 120ºC temperature of and 15 psi pressure. The coated fabrics were characterized by Scanning Electron Microscopy, Inductively Coupled Plasma Mass Spectroscopy and colorimetric analysis. Antibacterial activity of the silver nanoparticle treated fabrics was determined both against Gram-positive and Gram-negative bacteria by colony counting method. The UV protection factor of the fabric samples was measured on a UV spectrophotometer via transmittance data in the range of 290–400 nm. The impact of density of silver nanoparticle deposition on the mechanical strength of the fabric was also evaluated. The microscopic images of the fabrics showed dense and uniform coating of silver nanoparticles. All the samples showed excellent antimicrobial activity and UV-protection that varied from very good to excellent (UPF 33.4-89.9). There was no degeneration of mechanical strength of the fabrics after treatment with silver nanoparticles. The silver nanoparticle treatment to fabric also showed excellent durability against repeated laundering.