(103)

Green Synthesis of Silver Nanoparticles from Cis-Bixin and Cis-Norbixin: Potential Application for Fuel Desulfurisation

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Abstract

Green methods have been actively pursued in recent years as an efficient, inexpensive and environmentally safe approach for nanoparticle formation over the conventional chemical methods. Nanoparticle mediated adsorptive desulfurisation has been considered as an alternative, ecofriendly approach for fuel desulfurisation. Fuel desulfurisation is indispensible due to the fact that the combustion of fuels containing sulfur compounds release sulfur oxide compounds into environment and engenders devastating consequences on the chemistry of atmosphere. The present investigation devoted to the possibility of green synthesis of silver nanoparticles (AgNPs) using cis-bixin and cis-norbixin carotenoids as reducing and stabilising agents and the possibility of synthesised nanoparticles for removal of sulfur compounds in fuel. Cis-bixin was extracted from the pericarp of the seeds of Achiote (Bixaorellana) tree and cis-norbixin was synthesised from cis-bixin. The synthesized AgNPs from both carotenoids were characterised using UV-Visible spectroscopic technique for Surface Plasmon Resonance and absorbance peaks were obtained at 391 nm for cis-bixin and 405 nm for cis-norbixin AgNPs. The effect of temperature, pH, ionic strength of $AgNO_3$ solution, time and stability of the formed AgNPs under electrolytic conditions were studied using UV-Visible spectroscopy and results revealed that the room temperature was paragon for optimum synthesis and AgNPs were stable in slightly acidic, neutral and slightly basic pHs and in different concentrations of NaCl (upto 0.2 M for cis-bixin and upto 0.3 M for cisnorbixin AgNPs). Synthesised AgNPs were used to investigate the fuel desulfurisation potential by using commercial kerosene as testing fuel material. For the comparative purposes $NaBH_4$ reduced AgNPs were used. The adsorption of sulfur compounds in oil medium onto surface of AgNPs in aqueous medium produce self-assembled sulfur compounds adsorbed AgNP layer (interfacial material) on the oil/aqueous interface. The potential of the synthesised AgNPs for desulfurisation of kerosene was confirmed by analysing the sulfur content in each kerosene sample and formed interfacial material through X-Ray Fluorescence (XRF) spectroscopy. The formed interfacial material was further characterised through FTIR spectroscopy. The XRF results revealed that the AgNPs synthesised from cis-norbixin has the highest capability to reduce considerable amount of sulfur in kerosene compared to the other synthesised AgNPs. This study reports the possibility of rapid green synthesis of AgNPs form cis-bixin and norbixin under room temperature and feasible pH conditions followed by the capability for desulfurisation of fuel.

Keywords: Green synthesis, Silver nanoparticles, Cis-Bixin, Cis-Norbixin, Fuel desulfurisation