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Optimization of biobased synthesis of silver nanoparticles using fruit peel solid waste by RSM for removal of anthropogenic pollutants from water

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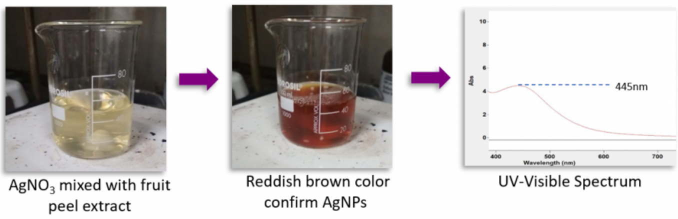
PURPOSE OF THE ABSTRACT
Green synthesis has gained worldwide attention among researchers as a sustainable, affordable, and eco-friendly process for fabricating various materials and nanomaterials. The traditional methods of nanoparticle synthesis are costly, toxic, and harmful to the environment [1]. The green approach of synthesis helps to overcome the destructive effects of these methods. Utilization of waste fruit peel is being done in this study for the successful synthesis of silver nanoparticles (AgNPs). Citrus limetta peels extract is used as a reducing, capping, and stabilizing agent. The biobased AgNPs possessed high stability in an aqueous colloidal solution. Central composite design (CCD) of response surface methodology (RSM) was applied to optimize the process conditions of AgNPs synthesis via a low-cost and single-step process. Three empirical factors of synthesis including temperature, the concentration of AgNO3 solution, and time of reaction were used as independent variables of the model and the dependent variable is the peak intensity of surface plasmon resonance (SPR). The UV-Visible spectroscopy showed characteristic absorption maxima in the wavelength ranging from 430nm to 470nm. The quadratic model was significant with a p-value < 0.05 and R2 value 0.9365. The characterization of the prepared AgNPs was conducted by Fourier transform infrared spectroscopy (FTIR), dynamic light scattering (DLS), zeta potential, scanning electron microscopy (SEM), energy dispersive x-ray spectroscopy (EDX), and powder x-ray diffraction (PXRD). The FTIR analysis showed that AgNPs were capped by various biological molecules. Phytochemical screening was also performed to confirm the presence of flavonoids, alkaloids, terpenoids, proteins, and reducing sugars. SEM and TEM confirm the spherical shape of the nanoparticles. XRD pattern reveals significant diffraction peak at 38.01?, 44.22°, 64.45°, 77.42° and 81.51° attributes to (111) (200) (220) (311) and (222) planes of the polycrystalline face-centered cubic crystal structure of silver. The AgNPs have a zeta potential of ?20.2 mV [2]. The AgNPs obtained were evaluated for their ability to degrade 4-nitrophenol. Furthermore, DFT studies examined the properties of the compounds present in the fruit peel extract having to reduce and stabilize characteristics in the order as ferulic acid > gallic acid > p-coumaric acid > limonene > linalool.

FIGURES



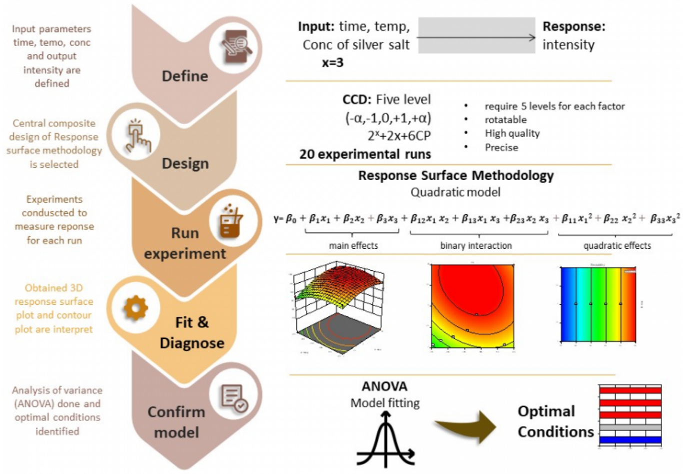


FIGURE 1

Green synthesis of AgNPs mediated by fruit peel extract

Orange peel extract is mixed with AgNO3 salt solution to obtain the biobased silver nanoparticles. The change in color of the solution to reddish brown confirms the synthesis of silver nanoparticles also confirmed by UV spectroscopy.

FIGURE 2

Design of experiment for silver nanoparticles synthesis by RSM methodolog

Three process parameters: time, concentration of AgNO3, and temperature were taken as the independent variables for intensity of the peak as the dependent response variable.

KEYWORDS

Response surface methodology | Green synthesis | silver nanoparticles | Catalytic reduction

BIBLIOGRAPHY

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