

Vibrational spectroscopy studies on biosynthesized silver nanoparticles

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Introduction

Silver nanoparticles (AgNPs) have been intensively investigated due to great potential applications, for instance, in technology, physical, biomedical and pharmaceutical sciences. These nanoparticles can be synthesized by chemical, physical and biological methods. In general, physico-chemical methods can be toxic, expensive, produce NPs with low yield and limitations for medical/pharmaceutical use (contamination from precursors, solvents, etc.). Thus, the biosynthesis of NPs using plant extracts has become very important topic for research in recent years (Adil et al., 2015; Agressott et al., 2020). Plant extracts contain variety of natural compounds with different molecular structures that exhibit reduction to metal ions to elemental metal nanoparticles. Hence, preparing metal nanoparticles with plant extracts match the concept of green chemistry for their production and also increased biocompatibility as great advantage in their application.

The increasing use of nanomaterials in wide range of products has initiated concern on their interactions with biological systems and potential cause of toxicological effects. Already some of the potential risks of nanotechnological products has been described, but their general toxicity remains

largely unknown due to the lack of scientific data about what happens when NPs entering into living cells (Huang et al., 2017; López-Lorente and Mizaikoff, 2016).

As information about the physical, chemical, and biological properties of the NPs is still missing, in this work, we try to go a step further in revealing characteristics of biosynthesized AgNPs by performing a vibrational spectroscopic investigation.

Materials and methods

NPs are obtained by using AgNO₃ as a silver precursor and the aqueous plant extract as a bio-reducing agent. The overall incubation process was carried out on room temperature, using orbital shaker in dark conditions, and the obtained AgNPs were purified through centrifugation.

Results and discussion

NPs with inherent infrared absorptions or functional groups present at their surface, and also different ligands attached to them, may be identified according to their vibrational signatures in a rapid, precise, and non-destructive way by directly characterization via Raman spectroscopy. Furthermore, vibrational spectroscopy allows the

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detection of functional groups and adsorbed molecules at the surface of NPs, as well as monitoring changes of the interactions with other molecules including biological systems (Lopez-Lorente, 2016; Rygula et al., 2013). Raman spectrum of AgNPs was recorded in the region 2000–200 cm^{-1} . The peaks at around 500, 900–1000, and 1500–1600 cm^{-1} might be assigned to a shift of the twisting, rocking, and scissoring modes of NH_2 group, respectively, indicating an amine-silver interaction (Liu-Bin et al., 2011). Symmetric and asymmetric $\text{C}=\text{O}$ stretching vibrations of carboxylate group, corresponds to bands registered at region 1300–1600 cm^{-1} . Also, stabilization of AgNPs by chemical bonding of the amino and/or carboxylate groups of the plant molecules with the silver atom can be detected. Our future analysis will be focused to investigate possible interactions occurring, which can help to predict potential toxicity and identify agent-induced alterations occurring within cells.

Conclusion

It is expected that one combined/integrated analytical techniques approach will provide next-generation tools for studying nanoparticles in a wide variety of complex application in pharmaceutical or biomedical scenarios.

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