T513: Applications of Nanotechnology for the Environment and Circular Economy

Lignin nanoparticles as a carrier for biopesticides: characterization and evaluation against a Chilean plague

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Lignin nanoparticles have received significant interest in recent years because of their non-toxic biocompatible and biodegradable properties. Several studies report molecules encapsulation, drug delivery and UV protection which highlight the potential of these nanoparticles as an effective tool for the delivery of compounds in several fields including agriculture. In this regard the use of biopesticides for a sustainable pest control remains a challenge because of high volatility and degradation of these compounds under field conditions. Thus, the encapsulation of biopesticides in biopolymeric nanoparticles emerges as a promising system that provides protection to the encapsulated compound, a sustained release, and a reduction of the applied biopesticide, contributing to efficient pest control in organic agriculture. The aim of this work was to synthesize and characterize geraniol-loaded lignin nanoparticles and to evaluate the acaricidal effect of these against Brevipalpus chilensis, a Chilean pest that affects grapevine fields.

Nanoparticle size, polydispersion and surface charge were determined by dynamic light scattering, while nanoparticle morphology was observed by scanning transmission electron microscopy. Encapsulation efficiency was evaluated using the extraction method and subsequent quantification by UPLC. Also, UV-exposition assays were performed to compare encapsulated and free geraniol degradation. Finally, bioassays were performed in Brevipalpus chilensis. Specifically nanoparticles solutions were sprayed on mites situated on a leaf disk and mortality and repellence were evaluated at 24h, 48h and 72h.

The nanometric size and highly negative surface charge of geraniol loaded lignin nanoparticles (200.9±27.2 nm and -29.4 mV respectively) reflects the effectivity of nanoprecipitation method and the stability of the synthesized nanoparticles in aqueous suspension. The above was associated with a spherical morphology. An encapsulation efficiency of 45% was obtained which is similar to that reported for this type of nanoparticles. UV- exposition assays showed less degradation of encapsulated geraniol compared to the free compound suggesting that the encapsulation of geraniol on lignin nanoparticles protects against UV degradation which could lead to a decrease the concentration of biopesticides to be applied in crops. Finally, bioassays performed in Brevipalpus chilensis showed a significant increase in mortality after 72h of exposure, and also a significant increase in repellence was observed when compared to free compound.

Our results suggest that lignin nanoparticles have the potential to be used as a platform for the delivery of biopesticides by protecting the encapsulated compound and increasing the pesticidal activity when applied to the pest of interest.

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References

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