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Evaluation of a Seed Coating Containing Essential Oil-Loaded Mesoporous Silica Nanoparticles against Pea Bacterial Blight

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Extended Abstract

The current lack of preventive and treatment measures available against bacterial diseases affecting crops is an important problem in agriculture. The use of antibiotics and copper compounds is restricted and can cause bacterial resistance and negative impacts on the environment [1, 2]. Nevertheless, other successful treatment methods have not been fully established. Promising natural compounds exist which have been proven to have strong antimicrobial properties, such as essential oils, and could be used to target bacterial phytopathogens. However, the volatile nature of these compounds limits their application and use in agriculture and a suitable delivery method is extremely desirable.

The aim of this study is to evaluate the use of mesoporous silica nanoparticles (MSNPs) to encapsulate essential oils and be used as a preventive and control measure against *Pseudomonas syringae* pv. *pisi*, the causative agent of pea bacterial blight [3]. MSNPs allow for a targeted and controlled delivery of the essential oil in the presence of the bacterial pathogen. Essential oils are an environmentally-friendly and safe alternative to antibiotics and other antibacterial agents and the use of nanoparticles as a delivery vehicle allows the oils to be maintained in their active form for long periods of time until their release is needed. MSNPs can protect the loaded biocide from evaporation or degradation while improving their stability and miscibility in aqueous solutions. Additionally, silica is a safe, biodegradable and biocompatible material [4] that is naturally present in plant systems and has been shown to have mainly positive effects on plant growth and development [5, 6, 7, 8].

The present study evaluated the effect of 41 essential oils against *P. syringae* pv. *pisi* and compared it to the effect on two other bacterial strains; *Pectobacterium carotovorum* and *Pseudomonas fluorescens*. The effect was shown to be strain-specific and one of the most effective oils against *P. syringae* pv. *pisi*, ajwain oil, was selected for encapsulation into the MSNPs, which were then incorporated into an alginate seed coating to treat the seeds prior to sowing. Using a seed treatment as a biocide application method reduces the quantity of antimicrobials needed, as well as the amount of nanoparticles released to the environment, when compared to other methods such as soil or foliar applications. This decreases the risk of microbial resistance to biocides while increasing the safety and efficacy of the product.

The effect of different alginate formulations on the plant's germination, growth and development was studied to assess the influence of MSNPs and the use of this technology as a seed treatment against seed-borne pathogens. Peas coated with loaded MSNPs appeared to better resist infection and grow taller than control seeds. Further experiments will be performed to optimise the loading of the MSNPs and maximise the killing efficacy against the pathogens. Additionally, the applications of this study can be extended to both other pathogens as well as other host plants. To our knowledge, this is the first report of MSNPs loaded with a natural biocide and incorporated into an alginate seed coating to protect peas from bacterial phytopathogen *Pseudomonas syringae* pv *pisi.* The development of novel and safe biocide delivery methods is essential to optimise food production and achieve a sustainable agriculture in the future.

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