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INTRODUCTION

Biopolymer-based formulations have shown promise in controlling fruit pathogens, as they reduce environmental impact while helping to maintain product quality, thereby minimizing economic losses. Biopolymers are biodegradable, low-toxicity macromolecules derived from natural sources, such as chitosan and carboxymethylcellulose, which can be combined to form nanocapsules (NCs) through ionic interactions, enabling modified release of antimicrobial agents.^{1,2} This study evaluated the effects of eugenol-loaded NCs based on chitosan and carboxymethylcellulose in protecting nectarines against *Monilinia fructicola*, a pathogen responsible for brown rot, a disease of global relevance.³

MATERIAL AND METHODS

NCs were prepared by the Layer-by-Layer method using chitosan and carboxymethylcellulose (2 mg mL⁻¹) in acetate buffer (pH 4.6).

Eugenol-loaded NCs were obtained by alternating deposition of cationic (LbL₁) and anionic (LbL₂) layers under stirring (25 °C, 900 rpm). After each layer, NCs were centrifuged and washed. Eugenol-free NCs were prepared as controls.

RESULTS

The average sizes observed were 158 nm for the nanoemulsion (Ne), 360 nm for chitosan NCs (Ne-LbL₁NCs), and 398 nm for carboxymethylcellulose NCs (Ne-LbL₂NCs). In addition to demonstrating good adherence to the fruit surface, the NCs exhibited gradual eugenol release following first-order kinetics.

Fig. 1. Preparation of chitosan and carboxymethylcellulose NCs containing eugenol.

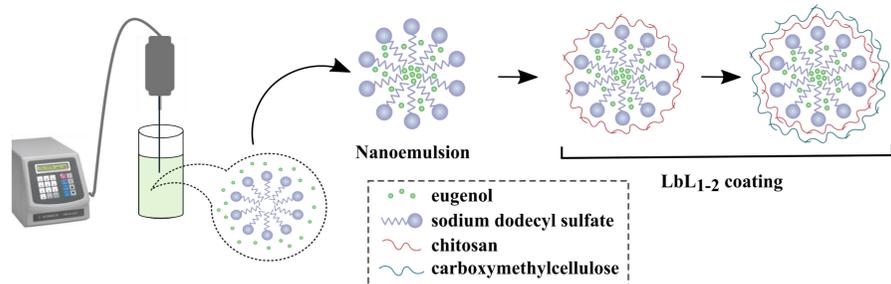
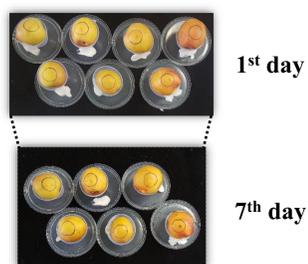


Fig. 2. Application of NCs in nectarine and inoculation of *Monilinia fructicola*.



Monilinia fructicola (isolate PpMfSP15/575) was cultured and inoculated onto sanitized 'Sungold' nectarines. Fruits were treated with controls, NCs (with/without eugenol), and iprodione, inoculated (10⁵ conidia mL⁻¹), and incubated in a humid chamber, with daily evaluations over 7 days.



CONCLUSIONS

The polymeric nanocapsules containing eugenol proved to be promising for fruit coating in the protection against brown rot caused by *Monilinia fructicola*, to increase fruit storage or shelf life, in addition to using much less toxic natural substances as fungicides.

Fig. 3. Apparent hydrodynamic diameter and ζ -potential of Ne and NCs.

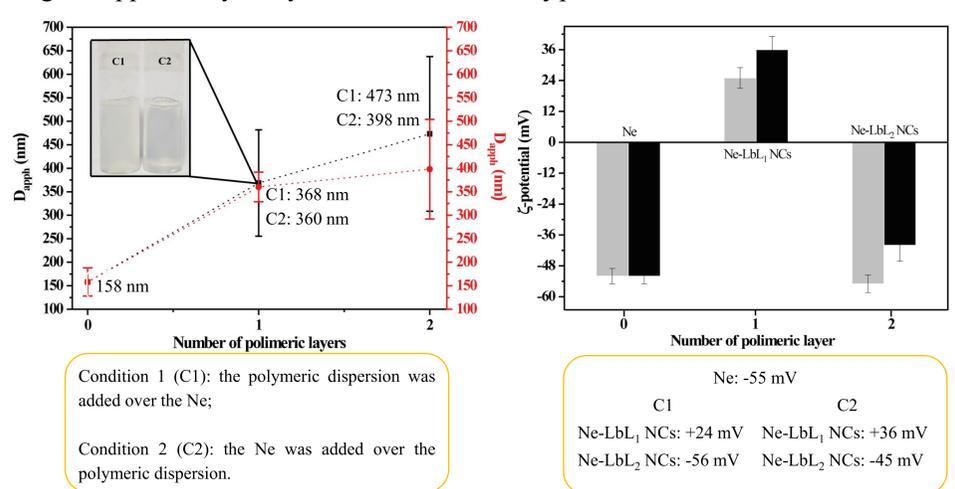
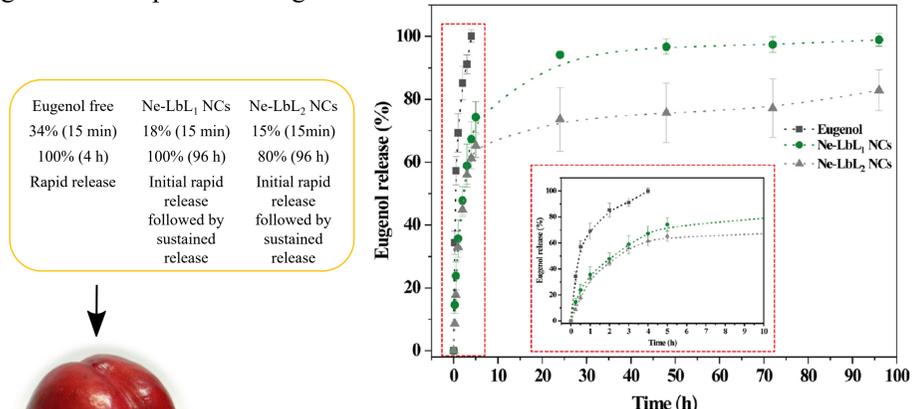


Fig. 4. Release profile of eugenol from NCs.



Efficacy: Ne-LbL₁NCs > Ne-LbL₂NCs ≈ free eugenol > fungicide

Ne-LbL₂NCs: moderate control, but inferior to Ne-LbL₁NCs

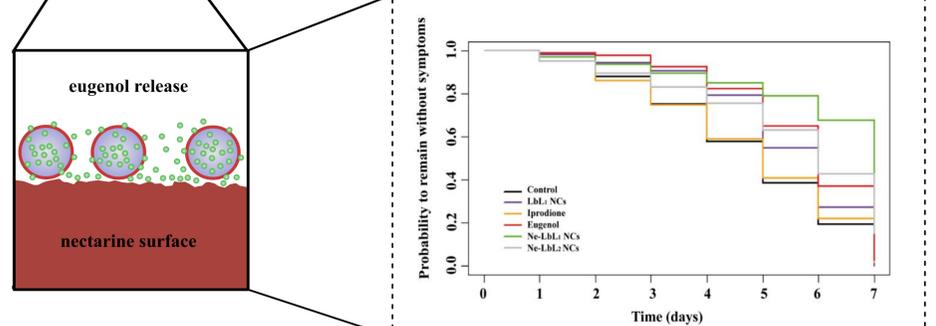


Fig. 5. Kaplan-Meier curves showing survival of symptom-free nectarines over time.

Acknowledgments / Financial Support



References

- Jacumazo et al. Carbohydrate Polymer, 2020, 230, 115562.
- Jacumazo et al. Journal of the Brazilian Chemical Society, 2023, 34: 1030-1039.
- Pereira et al. Tropical Plant Pathology, 2018, 44, 120.