

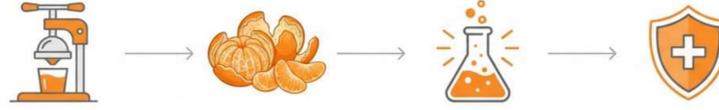
Valorization of Mandarin Juice Byproducts through Freeze-Dried Encapsulation of Phenolic Compounds

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INTRODUCTION

Polyphenols in mandarins have antioxidant and anti-inflammatory properties, but juice processing generates byproducts like peels and pulp that are often discarded despite being rich in these compounds. Their stability is limited by heat, light, and oxygen, but encapsulation, especially freeze-drying can protect polyphenols, mask bitterness, and allow controlled release. Using carriers like maltodextrin, dextrans, and gums, this study compares three encapsulating agents to maximize polyphenol retention, promoting sustainable use of food waste and creating added value.



RESULTS

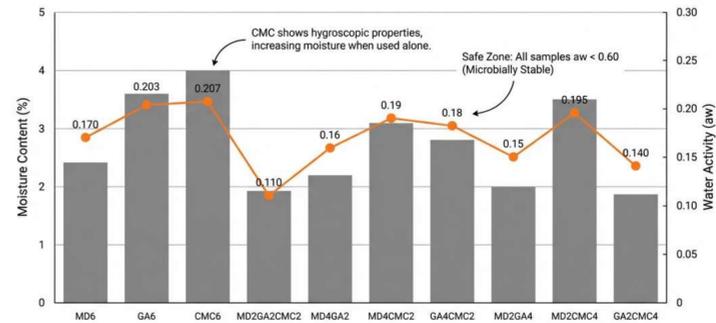


Figure 1. Moisture content and water activity of microcapsules

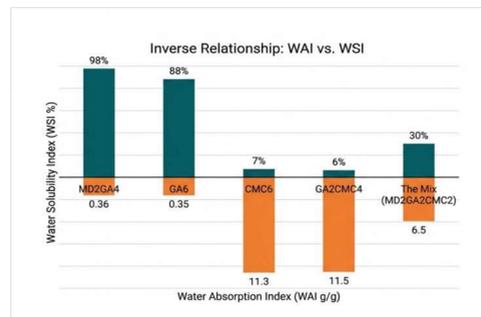


Figure 2. Solubility properties of microcapsules

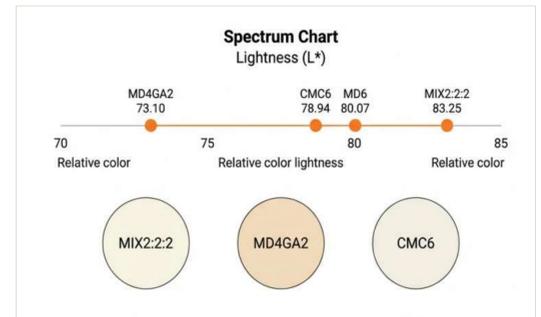
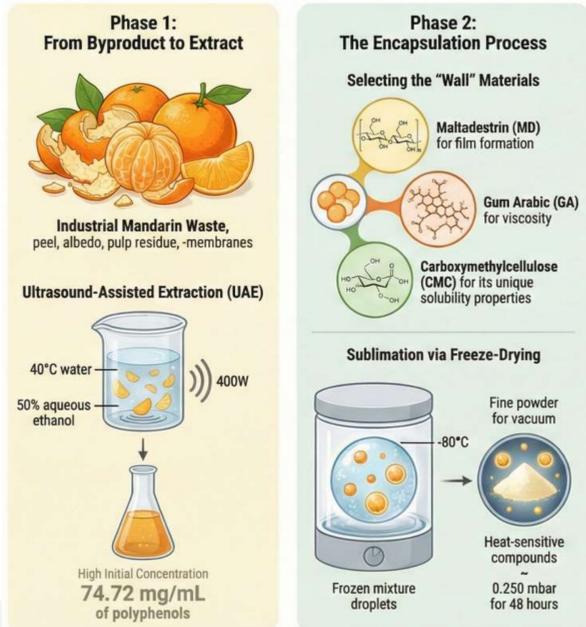


Figure 3. Color properties of microcapsules

MATERIALS & METHODS

Mandarin juice byproducts were freeze-dried and used for polyphenol extraction. Ultrasound-assisted extraction (50% ethanol, 40 °C, 30 min) yielded a 74.72 mg/mL extract, characterized by UV-VIS and HPLC.



Analysis

Physical properties (color, WSI, WAI, moisture, water activity) were measured using standard methods. Encapsulation efficiency was determined via Folin-Ciocalteu assay, and individual phenolics were identified by HPLC. All measurements were done in triplicate and analyzed statistically (ANOVA, Tukey HSD, 95 % confidence).

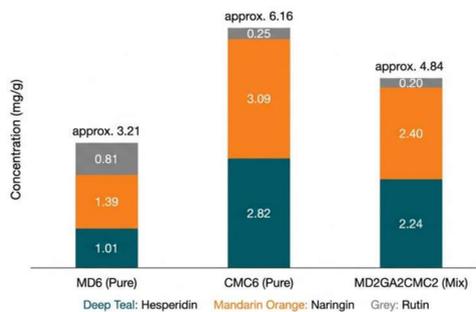


Figure 5. Retention of flavonoids in microcapsules

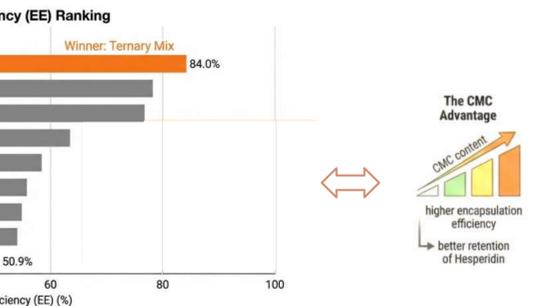


Figure 4. Encapsulation efficiency of microcapsules

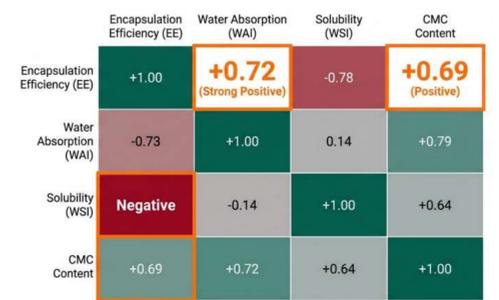


Figure 6. Statistical correlations & interaction of main results

CONCLUSION

The study demonstrates that freeze-drying is a promising and effective technique for the valorization of underutilized mandarin juice byproducts by encapsulating their bioactive phenolic compounds. Optimal Formulation: A wall material mixture containing MD, GA, and CMC in equal proportions (MD2GA2CMC2) proved to be the most effective for the freeze-drying process. This combination achieved the highest retention of total phenols and resulted in a product with low moisture content (1.936%) and low water activity (0.110), indicating excellent shelf stability



Acknowledgments:

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