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Maltodextrin and Gum Arabic as Carriers for Hesperidin Encapsulation: Influence of Drying Technique on Microcapsule Properties

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INTRODUCTION

*H*esperidin is the main bioflavonoid of citrus fruits, such as sweet orange, mandarin, and lemon, and is also found in high concentrations in citrus byproducts, especially in the citrus peel.

Numerous studies have shown that hesperidin exhibits a wide range of biological activities, among which antioxidant, anti-inflammatory, and vasoprotective effects are particularly prominent. However, its application in food and pharmaceutical products is limited due to poor solubility, low stability, and sensitivity to environmental factors such as light, temperature, and pH. Encapsulation, a process of "entrapping" bioactive compounds within carriers such as maltodextrin and gum Arabic, has shown potential to improve the stability, solubility, and practical application of hesperidin.

The aim of this study was to investigate the effect of two encapsulation techniques, freeze-drying and spray drying, on the stability, solubility, and bioavailability of hesperidin obtained from citrus peel, as well as to characterize the resulting microcapsules and compare them with commercial and pure hesperidin.

Materials and methods

Materials

Family farm OPG Pačić provided samples for this study (whole citrus fruits, satsuma mandarin, Citrus unishu, medium late variety *Kuno*). In the season 2021/2022, citrus fruits were cultivated and harvested in Metković, Neretva Valley, Croatia. Immediately after harvesting, the peel was removed and stored at -80 °C. Before the extraction, the peel was dried, ground in a laboratory mill (MRC Sample mill C-SM/450-C, Holon, Israel) and sieved (mesh size - 2 mm).

Chemicals

Carrier materials: maltodextrin (DE:7-9) and Arabic gum were purchased from Sigma Aldrich (Burlington, MA, USA). Standard hesperidin (purity 97 %) was purchased from Sigma Aldrich (Burlington, MA, USA). Olive oil (cold-pressed) was obtained from Kemig, Ltd (Zagreb, Croatia). Methanol and acetic acid were purchased from J.T. Baker (Phillipsburg, NJ, USA).

Methods

Chemical analyses included HPLC quantification of hesperidin and determination of encapsulation efficiency. Structural characteristics and stability of the microcapsules were evaluated by thermogravimetric analysis (TGA) and powder X-ray diffraction (PXRD). All experiments were performed in triplicate, and the data were statistically analyzed using ANOVA and the Tukey HSD test.

Acknowledgments:

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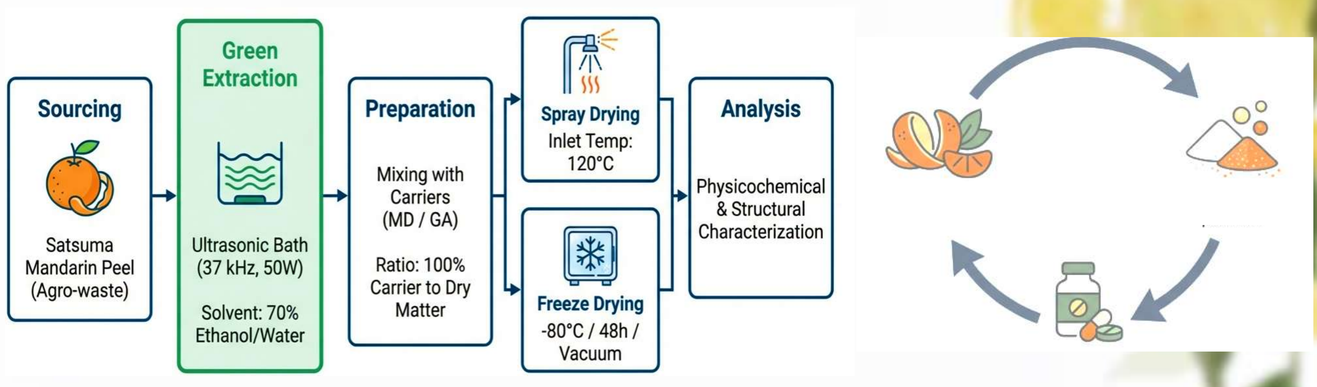

Figure 1. From Waste to Microcapsule: The Experimental Protocol

RESULTS AND DISCUSSION

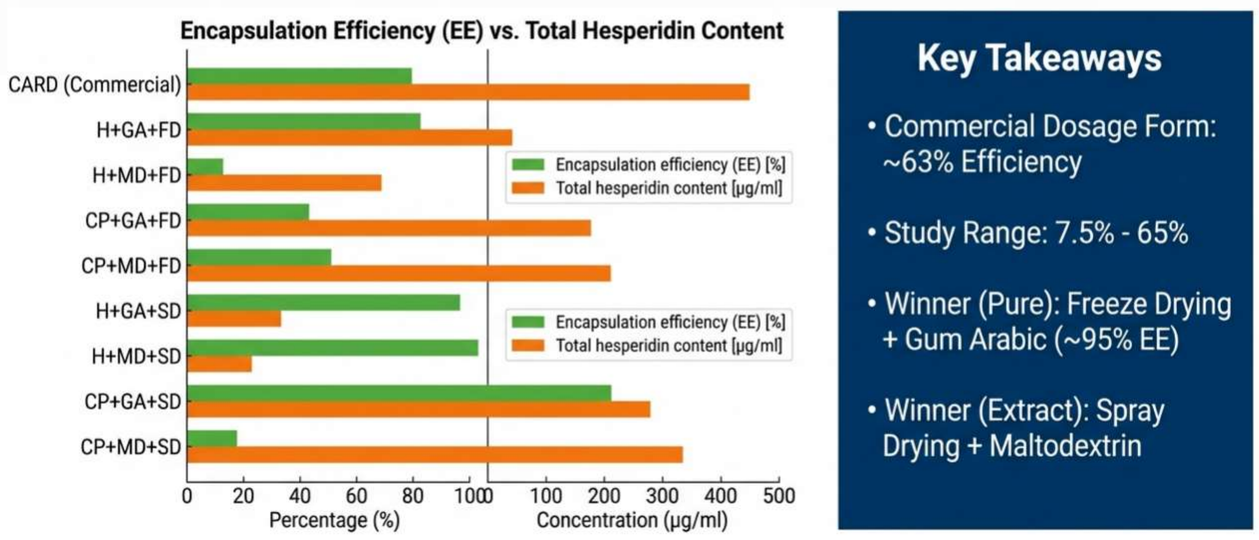

Figure 2. Encapsulation Efficiency (EE) vs. Total Hesperidin Content

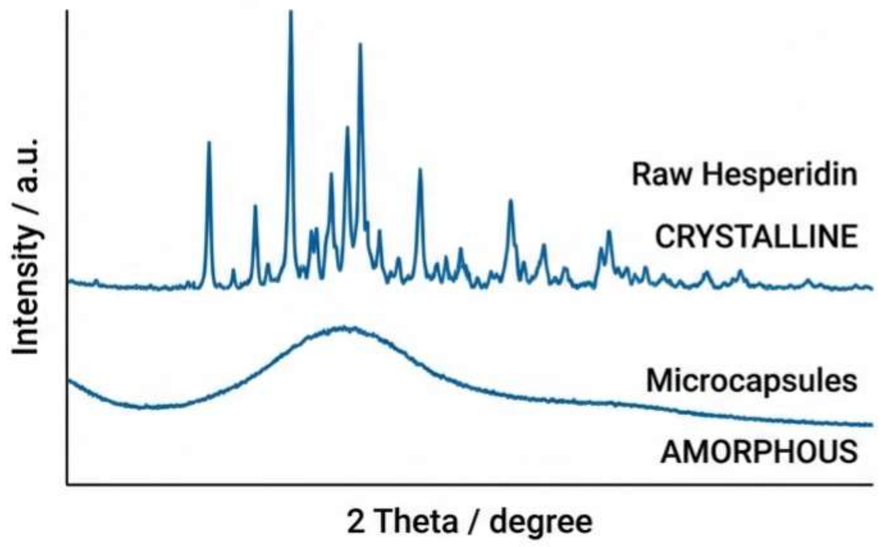

Figure 3. Structural Transformation: The Shift to Amorphous State

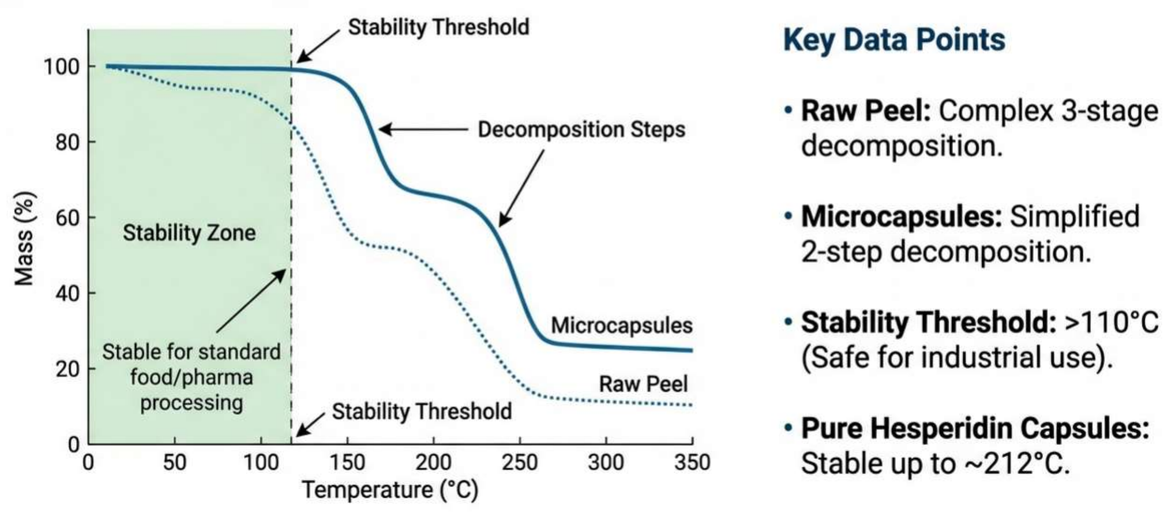

Figure 4. Thermal Resilience: Stability Above 110°C

Conclusion

Hesperidin microencapsulation preserves the total content of the active compound with high efficiency, while the amorphous form improves solubility and potential bioavailability. Additionally, the microcapsules exhibit thermal stability above 110 °C, making them suitable for use in food and pharmaceutical products.