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Impact of Storage on the Structure Stability of Starch-Based HPP Hydrogels Loaded with Natural Extracts

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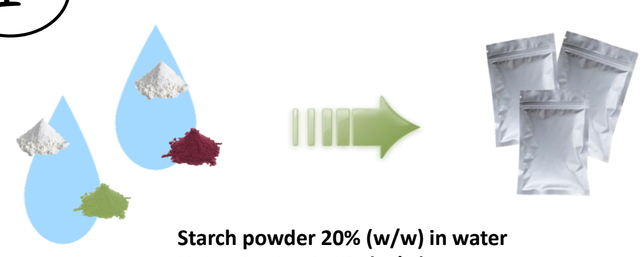
INTRODUCTION & AIM

Micronutrient deficiencies remain a major public health concern, particularly in low- and middle-income countries (Mkambula et al., 2020). Nutraceuticals' bioactive compounds, such as polyphenols, carotenoids, and phytosterols, can improve health but often face challenges like low solubility, chemical instability, and poor bioavailability (Damián et al., 2022). **To overcome these limitations, starch-based hydrogels have emerged as promising food-grade carriers for bioactive compounds.** Among the innovative techniques to produce such hydrogels, **high-pressure processing (HPP)** stands out as an eco-friendly method that enables cold gelatinization of starch at room temperature (Koshenaj et al., 2025). **This study aimed to evaluate during storage the stability and overall characteristics of HPP-produced tapioca starch hydrogels enriched with bioactive compounds.** By monitoring key properties over time, the study provided initial insights into the behavior and potential of these hydrogels for application in functional foods.

METHOD

Sample preparation

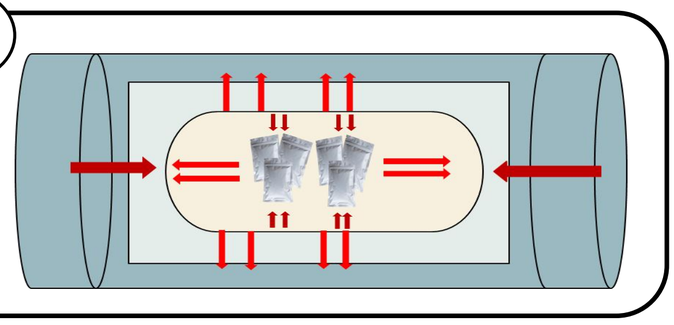
1



Starch powder 20% (w/w) in water
Natural extracts 2% (w/w)

HPP treatment

2



The obtained hydrogels

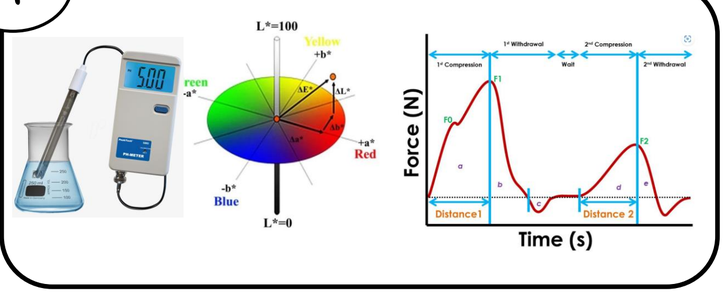
3

Loaded hydrogels with red grape extract

Loaded hydrogels with green tea extract

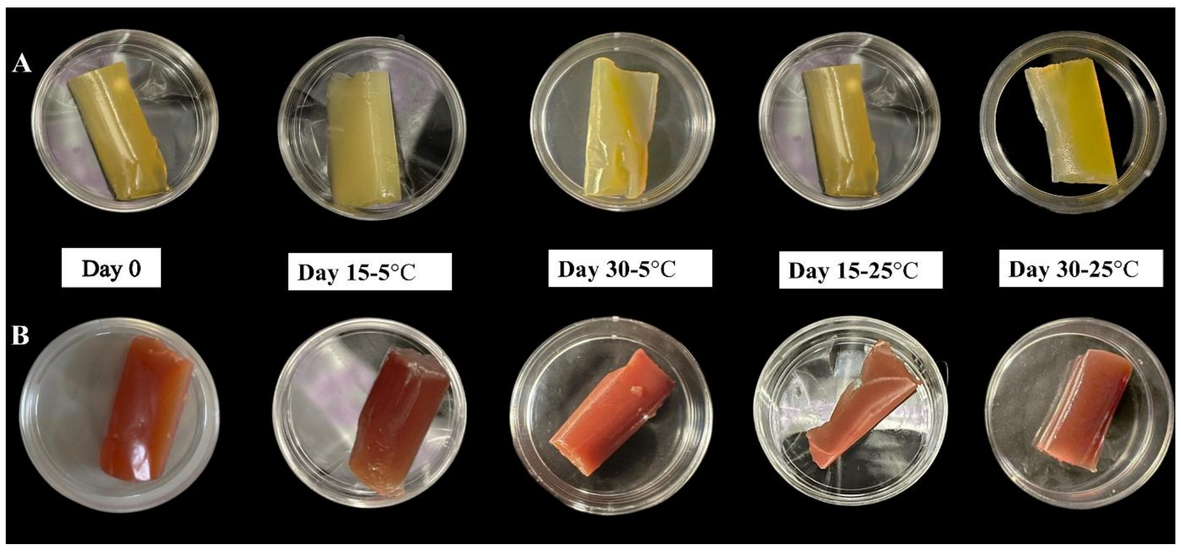
Characterization of hydrogels

4

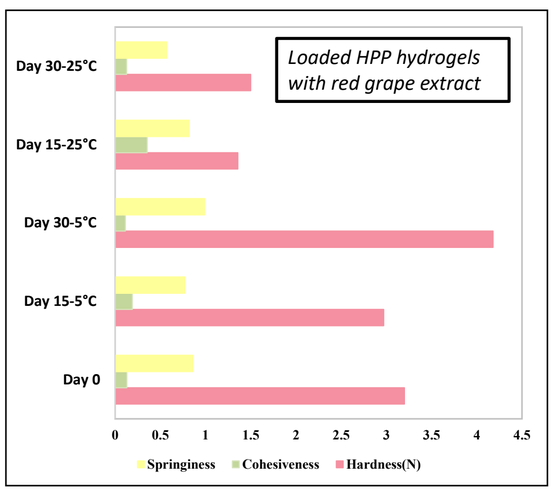


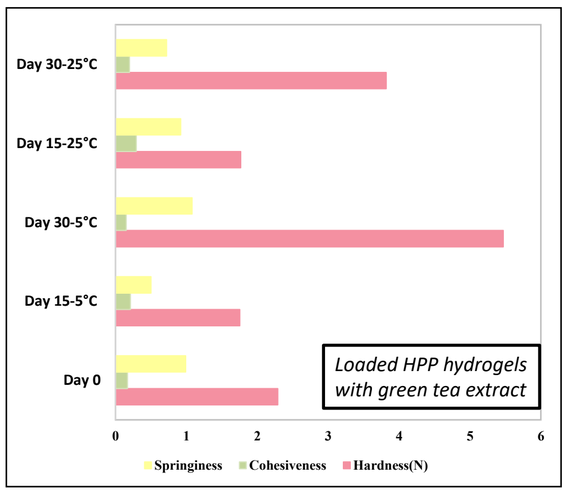
RESULTS & DISCUSSION

Pictures of starch-based HPP hydrogels loaded with natural extract during storage: A) Loaded HPP hydrogels with green tea extract, B) Loaded HPP hydrogels with red grape extract



Texture parameters of HPP hydrogels loaded with red grape extracts during storage at 5 °C and 25 °C.





- HPP hydrogels preserved their overall structure and **homogeneous appearance** during storage at both refrigeration and ambient temperatures.
- All samples showed a gradual decay of water-holding capacity over time, with colder conditions leading to a stronger loss due to enhanced **starch retrogradation**.
- Texture properties **changed during storage:** the gels initially softened but later became firmer, especially at 5°C, while cohesiveness and elasticity varied depending on temperature, indicating different rates of structural reorganization.

CONCLUSION/FUTURE WORK

This study demonstrated that tapioca HPP hydrogels show promise for food applications, maintaining structure and appearance during storage, although water-holding, texture, and color gradually change over time. Additionally, refrigeration better preserves their quality. **Future studies should focus on microbial stability, long-term storage, and scale-up to further assess the potential use of these materials.**

REFERENCES

Mkambula, P., Mbuya, M. N. N., Rowe, L. A., Sablah, M., Friesen, V. M., Chadha, M., et al. (2020). The unfinished agenda for food fortification in low- and middle-income countries: Quantifying progress, gaps and potential opportunities. *Nutrients* 12. doi: 10.3390/nu12020354

Damián, M. R., Cortes-Perez, N. G., Quintana, E. T., Ortiz-Moreno, A., Noguez, C. G., Cruceño-Casarrubias, C. E., et al. (2022). Functional Foods, Nutraceuticals and Probiotics: A Focus on Human Health. *Microorganisms* 10. doi: 10.3390/microorganisms10051065

Koshenaj, K., Carpentieri, S., and Ferrari, G. (2025). Starch-based hydrogels produced by high-pressure processing (HPP): The effect of high pressure on volume changes. *Innovative Food Science and Emerging Technologies* 102. doi: 10.1016/j.ifset.2025.104024