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Encapsulation of betalains from pitaya peel in guar gum: a strategy for the stabilization and valorization of agro-industrial waste

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Introduction

- **Sustainability:** Valorization of agro-industrial by-products aligns with circular economy goals.
- **Potential:** Dragon fruit peel is rich in betalains, natural pigments with strong antioxidant activity.
- **Challenge:** Betalains are unstable under light, oxygen, temperature, and pH variations.
- **Solution:** Encapsulation protects bioactive compounds and improves their application.

Objective

- To encapsulate dragon fruit peel betalains in guar gum and evaluate their properties

Methods

- **Extraction:** Ultrasonic bath (acidified water; pH 2, 4, 6) + centrifugation.
- **Encapsulation:** Mixed 1:1 with 1% guar gum, Ultra-Turrax,frozen (-18 °C), freeze-dried (-59 °C).
- **Analysis:** Encapsulation efficiency, color, aw, moisture, and DPPH activity.



Figure 1. Betalain extraction, encapsulation with guar gum.

Results and discussion

Table 1. Encapsulation efficiency of betalains from dragon fruit peel

	pH 2 (%)	pH 4 (%)	pH 6 (%)
BCC	70.59 ± 2.92	45.40 ± 4.66	17.92 ± 10.15
BXT	70.98 ± 2.13	43.34 ± 4.87	14.76 ± 9.42

Source: By the autors, 2026.

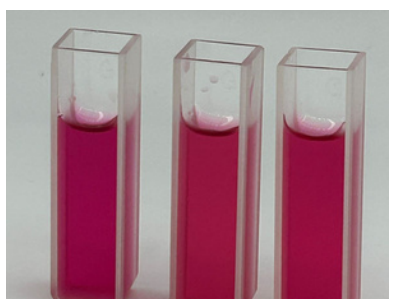


Figure 2. Betalain extraction



Figure 3. Encapsulated betalain

- **Efficiency:** Max at pH 2 (70.6-71.0%), lower at pH 4 (43.3-45.4%) and pH 6.
- **Stability:** Low moisture (7.9-11.5%) and aw (0.29-0.42).
- **Quality:** Red hue preserved; high DPPH activity (155.7-174.1 mg/mL).

Conclusion

- Guar gum effectively encapsulates betalains from dragon fruit peel, preserving pigments and antioxidant activity.
- Provides a sustainable, circular economy solution for agro-industrial waste.
- Holds potential as a functional biomaterial rich in natural bioactive compounds.

References and Acknowledgments

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