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WHEAT STARCH MODIFICATION ENHANCES 3D-PRINTED RED PROPOLIS GELS FOR DYSPHAGIA DIETS: PHENOLIC PROFILE AND BIOACTIVITIES DURING IN VITRO DIGESTION

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Oral

Resumo

Native starch hydrogels have limited functional and structural properties for 3D printing; however, Dry Heating Treatment (DHT) can improve their performance. In parallel, propolis is a natural product with bioactive properties of great interest for several applications, particularly in food applications. This study aimed to develop 3D-printed hydrogels from DHT-modified wheat starch and Brazilian red propolis, and to evaluate their gel-forming capacity, printability, and textural suitability for dysphagia diets. Furthermore, the bioactive properties of the gels under *in vitro* gastrointestinal digestion were investigated, with an emphasis on phenolic composition, bioaccessibility, antioxidant potential, and anti-inflammatory effects. Hydrogels were prepared with native and DHT-modified wheat starches (130 °C, 2 and 4 h) at different concentrations (4-10% d.b.) containing ~4% of propolis extract freeze-dried. At lower starch concentrations (≤6%), heterogeneous gels with agglomerates were formed, impairing 3D printing. In contrast, higher starch concentrations (8–10%) resulted in homogeneous gels, likely due to starch encapsulating propolis and allowing effective dispersion. Fork test confirmed that gels formulated with DHT_2h 8%, DHT_2h 10%, and DHT_4h 10% complied with the International Dysphagia Diet Standardisation Initiative (IDDSI) criteria, making them suitable for dysphagic diets. Regarding 3D printing, high infill densities (80–100%) resulted in lower fidelity compared to the designed model, whereas 60% infill density yielded the best results, with three printed cubes delivering ~500 mg of propolis, corresponding to the recommended daily intake. *In vitro* gastrointestinal digestion (INFOGEST 2.0) demonstrated that the starch matrix protected phenolic compounds, particularly in DHT-modified samples, enhancing phenolic bioaccessibility and antioxidant capacity of the 10% gels. Starch protected propolis from thermal degradation, with higher starch content (10%) presented higher antioxidant activity than 8%, consistent with greater phenolic bioaccessibility. Importantly, anti-inflammatory assays showed that starch alone had no effect, while propolis-containing gels significantly reduced NF-κB activation and pro-inflammatory cytokine release in macrophages after *in vitro* digestion, confirming their anti-inflammatory potential. Overall, this study showed that DHT-modified starch enabled the development of homogeneous, printable red propolis hydrogels with tailored textures for dysphagic individuals and enhanced functional properties. The combination of starch modification, propolis bioactivity, and 3D printing resulted in innovative systems with improved phenolic stability, antioxidant, and anti-inflammatory activities. Beyond their application as functional foods for dysphagia, these hydrogels also demonstrate potential as biomaterials for biomedical applications, highlighting the versatility of starch-based 3D-printed systems.

Programação

12:10 até 12:20 em 17/11/2025
Salão Imperial
(https://eventos.galoa.com.br/slacan-2025/calendar/activity/21144)

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Eixo Temático

- Alimentação e saúde (AS)

Palavras-chave

Texture tailoring

Functional food

Bioactive properties