

Novel food-grade bigels structured with wax from the native stingless bee (*Scaptotrigona mexicana*) and canola oil

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Abstract

Introduction: Bigels (BGs) are biphasic systems combining oleogel (OG) and hydrogel (HG) networks and are emerging as promising fat replacers in food systems. In this work, food-grade BGs were developed using *Scaptotrigona mexicana* wax—a native stingless bee species of ecological and biocultural importance—as an oleogelation agent. **Methods:** The OG phase was formulated with *S. mexicana* wax and canola oil at a 10:90% (w/w) ratio, while the HG phase consisted of potato starch and κ -carrageenan (10:2% w/w). BGs were prepared at different OG:HG ratios—25:75 (BG1), 50:50 (BG2), and 75:25 (BG3)—and their physico-chemical, mechanical, structural, and microstructural properties were evaluated. **Results:** Oil holding capacity was highest in BG1 (86.46%) and significantly decreased with increasing OG proportion, reaching 64.98% in BG3, which also reduced moisture content (67.44–23.06%), pH (4.83–3.88), hardness (0.52–0.11 N), and viscosity (0.153–0.059 Pa·s). Regarding color, the L^* value decreased from 48.3 to 26.6 and the b^* value from 23.5 to 17.8 from BG1 to BG3, reflecting the natural brown hues characteristic of the wax. Different types of microstructures were identified: (O/W) in BG1, bicontinuous in BG2, and (W/O) in BG3. Electrical conductivity markedly decreased from 4.01×10^{-1} mS/cm in BG1—indicating the HG as the continuous phase—to 5.9×10^{-6} mS/cm in BG3, attributable to the insulating nature of the OG phase. FTIR spectra exhibited characteristic peaks of the OG phase at 2918, 2852, 1740, 1462, and 721 cm^{-1} , with no evidence of new chemical interactions, suggesting physical integration determined by the OG:HG ratios. **Conclusions:** *S. mexicana* beeswax proved to be an effective oleogelator for developing stable food-grade OGs and BGs with tunable properties depending on OG:HG ratios, holding promise as fat replacers. Future research could enhance BG performance by incorporating polymers that improve HG phase stability.

Keywords: Bigel; Beeswax; Oleogel; Canola oil; Starch; κ -Carrageenan