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Biobased Derivatives From Olive Oil for Tuning Physically Crosslinked Poly(Vinyl Alcohol) Hydrogel Properties

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INTRODUCTION & AIM

Vegetable oils, commonly discarded by kitchens and restaurants, comprise unsaturated triglycerides, and the double bonds present in triglyceride units can be readily converted into interesting precursors through various synthetic methods.1 In this contribution, we present a straightforward chemical methodology for the revalorization of cooking oil, towards using waste vegetable oil as a source to produce new building blocks for various applications. Specifically, the epoxidation of olive oil primarily yields an epoxidized oil derivative. This same epoxidation pathway can be applied to generate hydroxylated derivatives, such as diols.

RESULTS & DISCUSSION

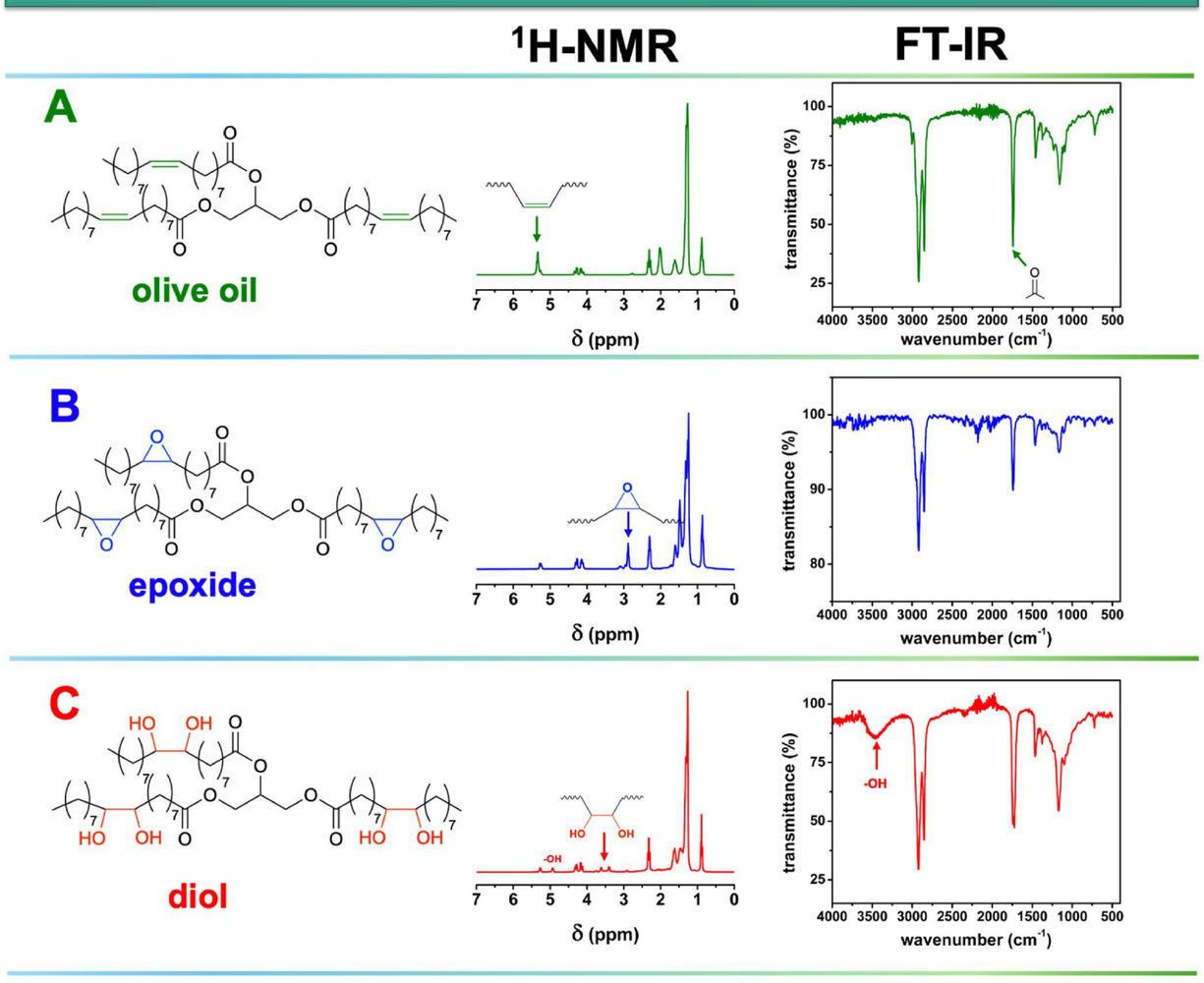

Figure 1: Chemical structures of olive oil (A), its epoxide derivative (B), and diol derivative (C), along with their corresponding ^{1}H-NMR and FT-IR spectra.

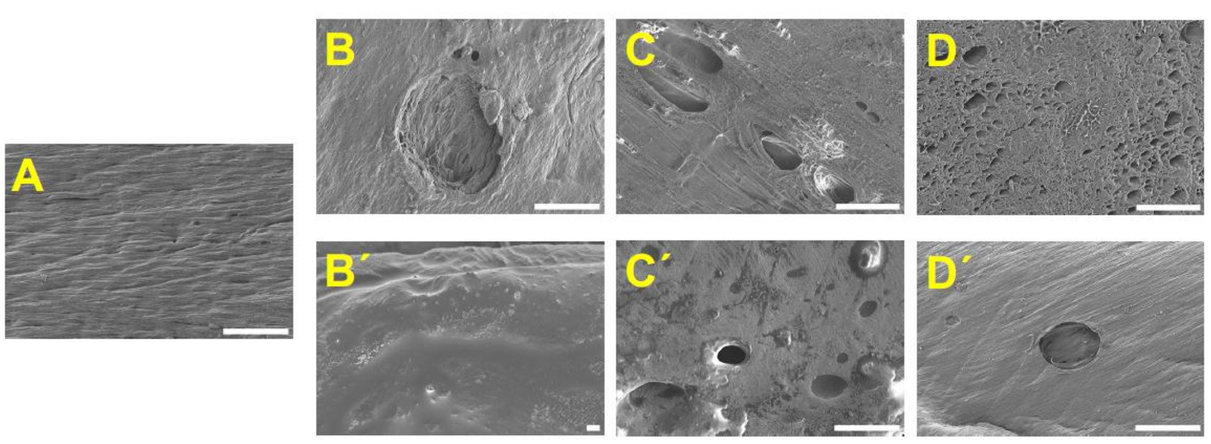

Figure 2: SEM images of PVA hydrogels prepared using 10 wt% PVA (A), and those prepared by adding 1 or 5 wt% olive oil (B, B′), epoxidized olive oil (C, C′), and diol olive oil (D, D′). Scale bar = 50 μm.

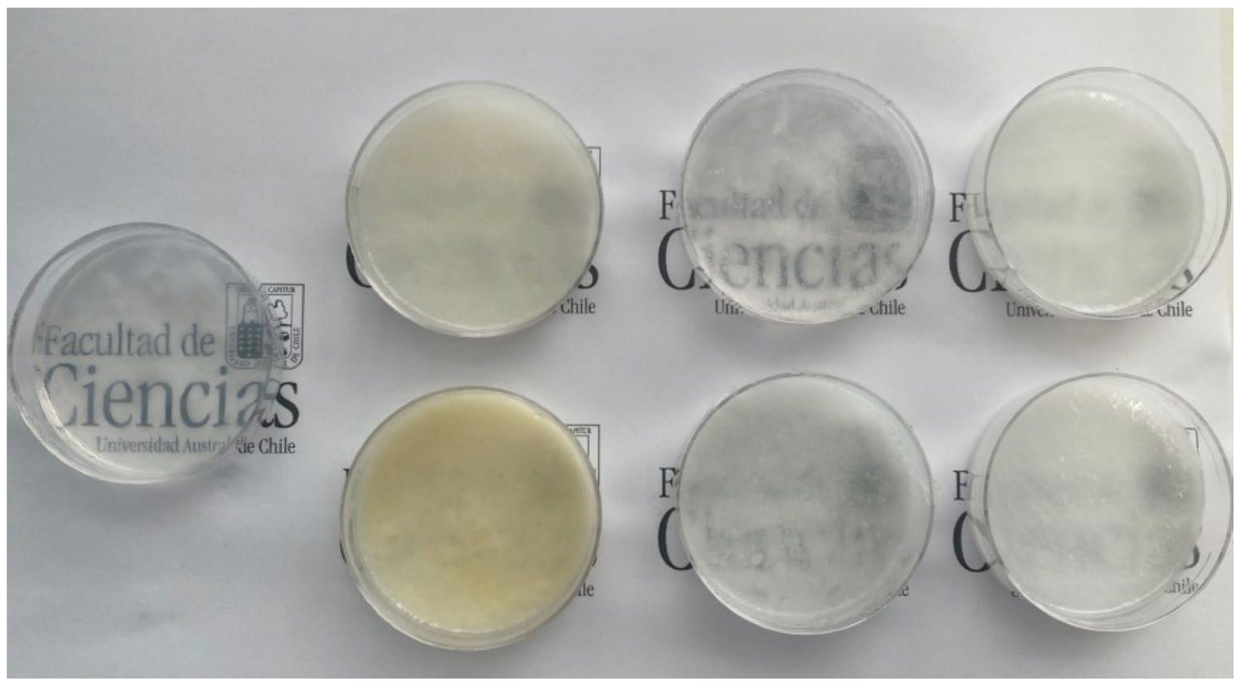

Figure 3: | Physical appearance of PVA hydrogels prepared using 10 wt% PVA (A), and those prepared by adding 1 wt% olive oil (B), epoxidized olive oil (C), and diol olive oil (D), and 5 wt% olive oil (B′), epoxidized olive oil (C′), and diol olive oil (D′).

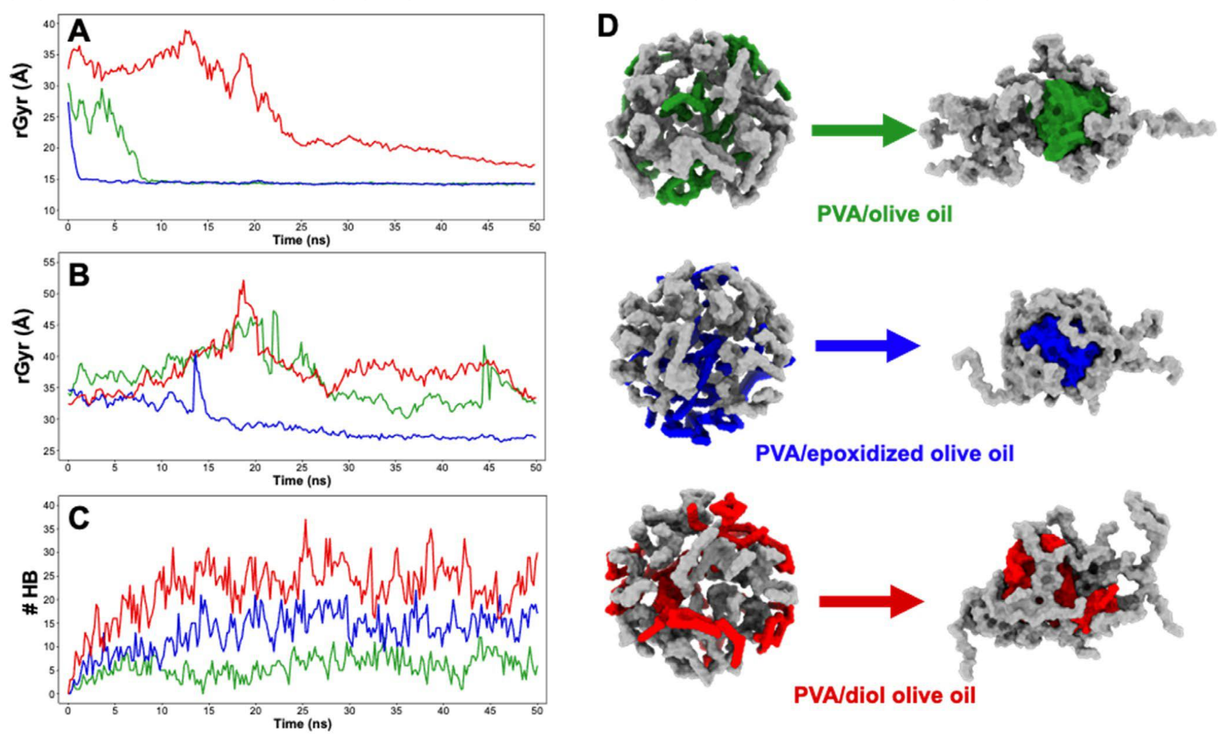

Figure 4: The radius of gyration (*rGyr*) for olive oil derivatives (A) and PVA chains (B) obtained from MDS; intramolecular hydrogen bond number between PVA and the olive oil derivatives during molecular dynamics simulations (C); and a snapshot of PVA/olive oil derivatives after 50 ns (D).

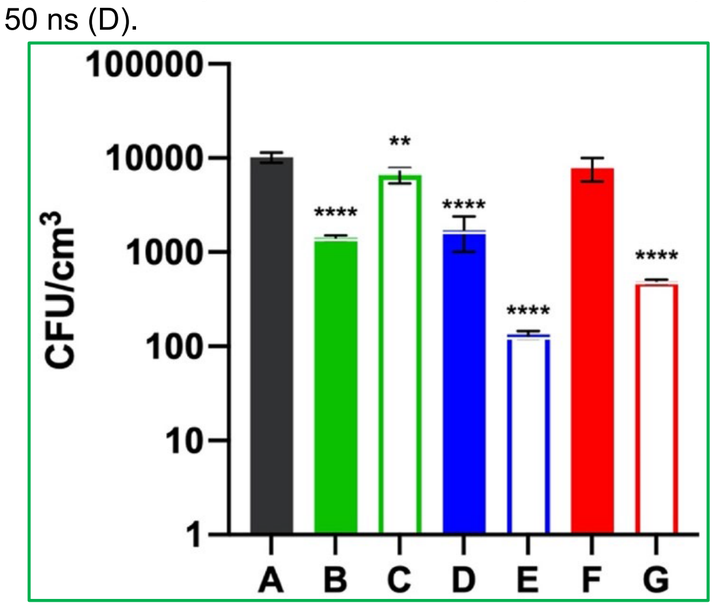

Figure 5. *Listeria monocytogenes* colony forming units (CFU/cm^3) after culturing for 24 h in the presence of PVA-based hydrogels prepared using 10 wt% PVA (A), and those prepared by adding 1% or 5% olive oil (B, C), epoxidized olive oil (D, E), and diol olive oil (F, G).

CONCLUSIONS

- In this study, we present a straightforward chemical methodology for the revalorization of cooking oil, towards using waste vegetable oil as a source to produce new building blocks for various applications. Specifically, the epoxidation of olive oil primarily yields an epoxidized oil derivative. This same epoxidation pathway can be applied to generate hydroxylated derivatives, such as diols.
- These oil-based derivatives were then incorporated into the formulation of physically crosslinked PVA hydrogels. Notably, hydrogels containing a 5 wt% diol derivative exhibited the highest compressive Young's modulus, suggesting a significant interaction between PVA and the diol.
- Although no apparent changes were observed in the spectroscopic response of the PVA-based hydrogels, molecular dynamics simulations indicated a profound interaction between PVA and diol molecules. Additionally, all synthesized PVA-based hydrogels demonstrated a bacteriostatic effect against *L. monocytogenes*, compared to pristine PVA hydrogel. This suggests that PVA-based hydrogels containing olive oil derivatives could have promising applications in various fields, including the tailored control of diol structures to modulate not only the mechanical properties of the hydrogels but also their antibacterial properties

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