Shellac-based encapsulation model incorporating calcium fluoride for oral care applications

Supplementary File

Table S1. Fluid properties of NaF solution (F^{-}: 5,000 ppm)

Parameter	Value	Unit
Surface tension (γ)	0.072	N/m
Density of solution (ρ)	1,000	kg/m^3
Acceleration due to gravity	9.81	m/s^2

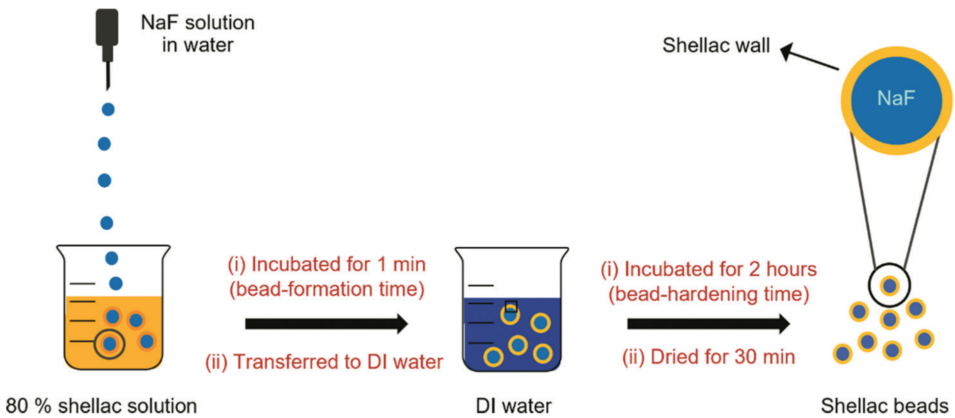

Figure S1. Schematic illustration detailing the synthesis steps for producing shellac beads via the extrusion method. Abbreviation: DI: Deionized.

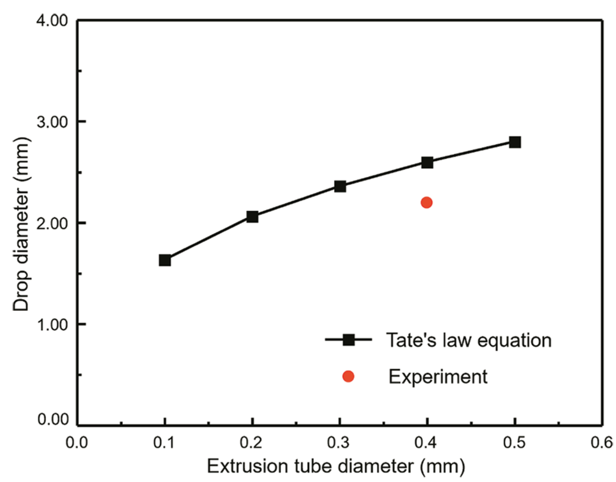

Figure S2. Drop diameter estimation for NaF solution via Tate's law across varied extrusion tube diameters (0.1–0.5 mm), with comparison to experimental data (0.4 mm tube).

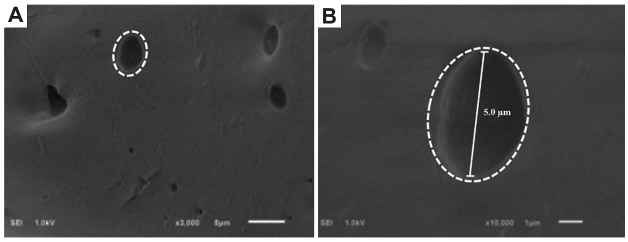

Figure S3. Scanning electron microscopy images of bead surfaces prepared using 70% ethanolic shellac solutions at magnifications of (A) ×3,000 (scale bar: 5 μm) and (B) ×10,000 (scale bar: 1 μm), with dashed circles indicating the positions of holes.

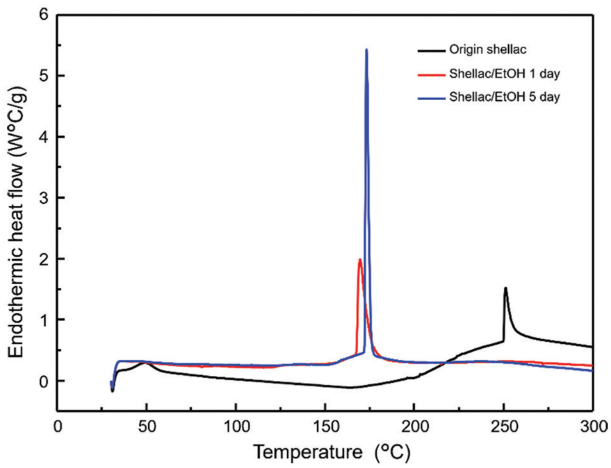

Figure S4. Differential scanning calorimetry thermograms comparing original shellac with shellac dissolved in ethanol for 1 and 5 days.

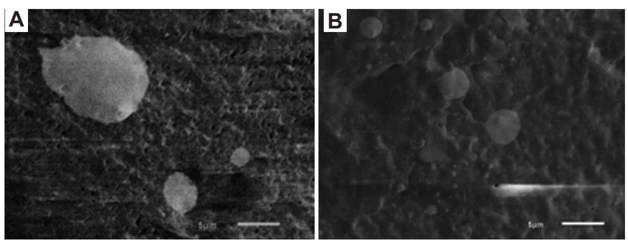

Figure S5. SEM images of shellac-bead surfaces showing CaF_2 deposition after soaking in $CaCl_2$ at (A) 2.5 % w/w and (B) 5.0 % w/w. Both figures A and B at magnifications of ×3,000 (scale bar: 5 μm).

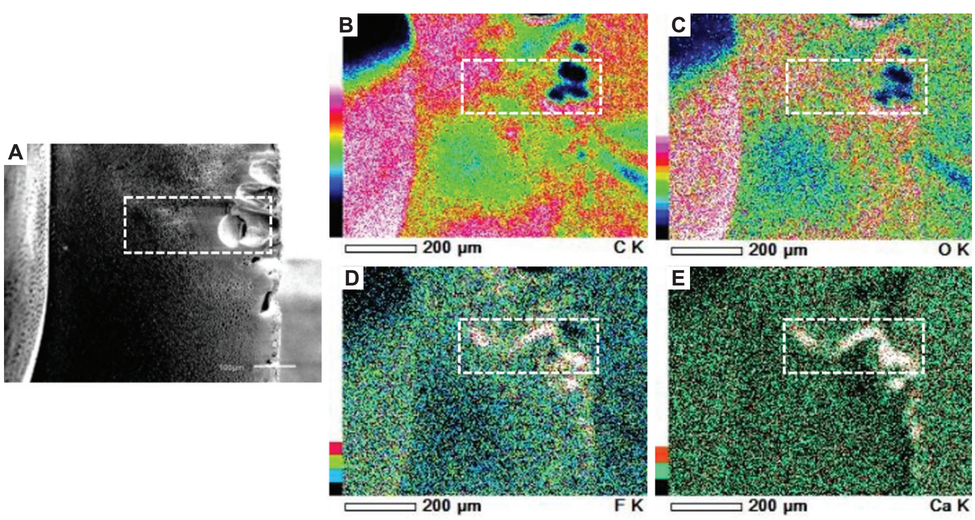

Figure S6. The tubular defects in the shellac wall contain CaF_2 inside. (A) Scanning electron microscopy image (Scale bars: 100 μm; magnification: ×100) and (B-E) Energy-dispersive X-ray spectroscopy (EDS) maps of C, O, F, and Ca, respectively, showing the cross-section of a shellac bead with CaF_2, demonstrating a tubular structure. C K, O K, F K, and Ca K refer to Kα emission lines detected through EDS mapping.