Supplementary Information (SI) for Biomaterials Science.

Sustainable and Durable Color Cosmetics: Riboflavin Phosphate-Mediated Photo-Crosslinked Casein Films with Tannic Acid

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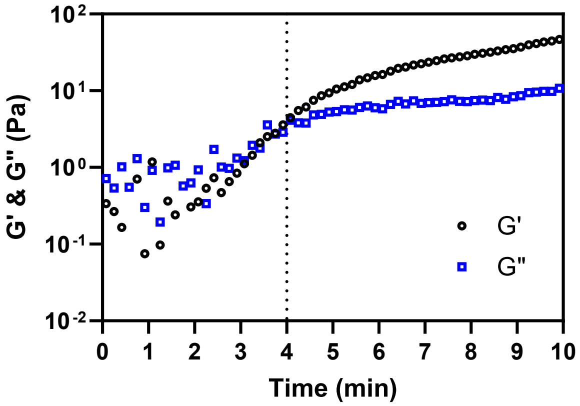

Fig. S1. Time-dependent rheological behavior of the casein-based film during photo-crosslinking. The graph shows the evolution of storage modulus (G') and loss modulus (G") over time. The dotted line indicates the gel point at approximately 4 min, where G' and G" intersect.

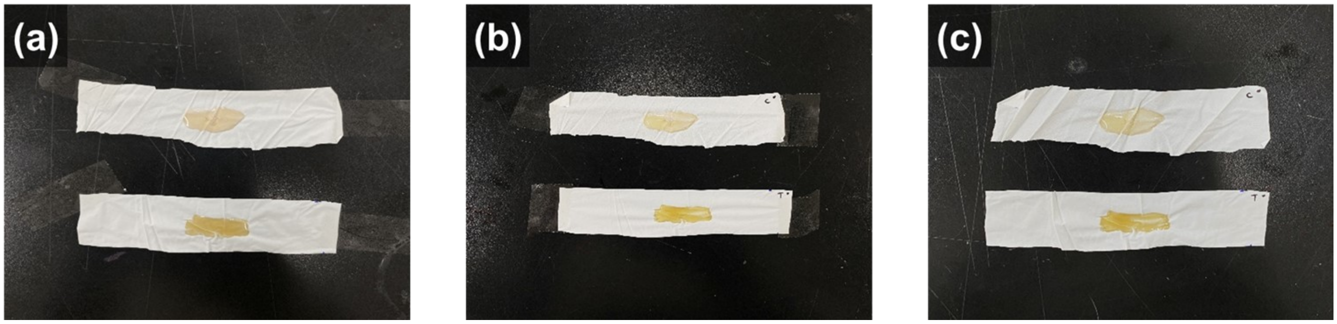

Fig. S2. Mechanical stability of Casein_BLO (upper strip) and Casein+TA_BLO (lower strip) films on nitrile glove strips (1 cm x 5 cm) under repeated stretching. (A) Films immediately after formation on the nitrile strips. (B) Films after 50 cycles of stretching and relaxation. (C) Films after 100 cycles of stretching and relaxation. Each cycle consisted of 20% elongation at a rate of 100 mm/min using a Universal Testing Machine (UTM). No visible damage or peeling was observed after 100 cycles. The films were prepared according to the method described in section 2.2, with TA concentration of 0.05% w/v for the Casein+TA_BLO sample.

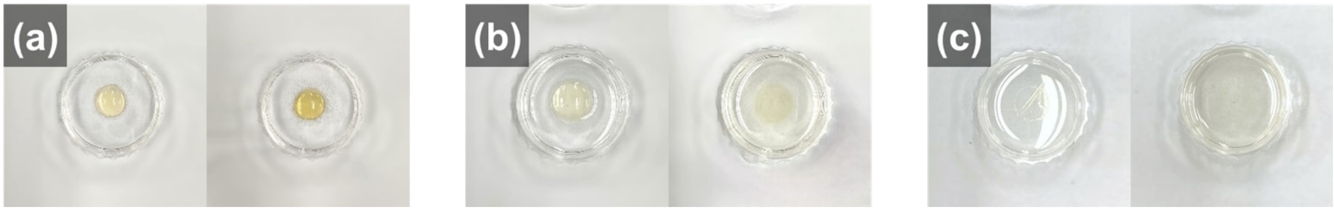

Fig. S3. Biodegradation of Casein_BLO (left) and Casein+TA_BLO (right) films in PBS solution (pH 7.4) at 37°C over time. Films were initially formed from 200 μL of precursor solution. (A) Day 0: immediately after immersion. (B) Day 1: partial degradation observed. (C) Day 2: complete degradation of both films, with only a faint outline remaining on the surface. PBS solution was replaced daily.

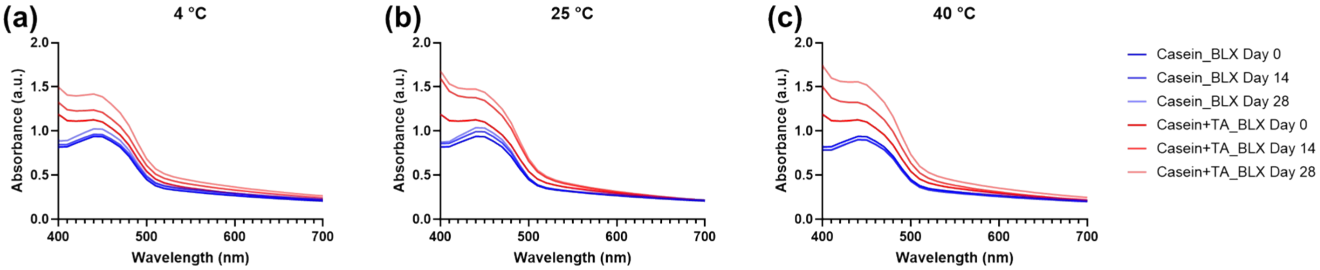

Fig. S4. Evaluation of color stability and tannic acid (TA) oxidation in film precursor solutions over time. Absorbance spectra (400-700 nm) of Casein_BLX and Casein+TA_BLX (0.05% TA) solutions in PBS (pH 7.4) were measured at 0, 7, 14, and 28 days. Solutions were stored at 4°C, 25°C, and 40°C and protected from light using aluminum foil. Casein+TA_BLX solutions showed higher absorbance in the 400-500 nm range. Casein_BLX solutions maintained consistent absorbance across temperatures and time. Casein+TA_BLX solutions showed slightly lower absorbance at 4°C and a gradual increase over time, with absorbance at 450 nm increasing by approximately 23%, 31%, and 38% at 4°C, 25°C, and 40°C, respectively, after 28 days.