Enzyme catalyzed oxidative gelation of sugar beet pectin: Kinetics and rheology

Sugar beet pectin (SBP) is a marginally utilized co-processing product from sugar production from sugar beets. In this study, the kinetics of oxidative gelation of SBP, taking place via enzyme catalyzed cross-linking of ferulic acid moieties (FA), was studied using small angle oscillatory measurements. The rates of gelation, catalyzed by horseradish peroxidase (HRP) (EC 1.11.1.7) and laccase (EC 1.10.3.2), respectively, were determined by measuring the slope of the increase of the elastic modulus (G′) with time at various enzyme dosages (0.125–2.0 U mL−1). When evaluated at equal enzyme activity dosage levels, the two enzymes produced different gelation kinetics and the resulting gels had different rheological properties: HRP (with addition of H2O2) catalyzed a fast rate of gelation compared to laccase (no H2O2 addition), but laccase catalysis produced stronger gels (higher G′). The main effects and interactions between different factors on the gelation rates and gel properties were examined in response surface designs in which enzyme dosage (0.125–2.0 U mL−1 for HRP; 0.125–10 U mL−1 for laccase), substrate concentration (1.0–4.0%), temperature (25–55 °C), pH (3.5–5.5), and H2O2 (0.1–1.0 mM) (for HRP only) were varied. Gelation rates increased with temperature, substrate concentration, and enzyme dosage; for laccase catalyzed SBP gelation the gel strengths correlated positively with increased gelation rate, whereas no such correlation could be established for HRP catalyzed gelation and at the elevated gelation rates (>100 Pa min−1) gels produced using laccase were stronger (higher G′) than HRP catalyzed gels at similar rates of gelation.

Chemical analysis confirmed the formation of ferulic acid dehydrodimers (diFAs) by both enzymes supporting that the gelation was a result of oxidative cross-linking of FAs.

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