Arabinoxylan-protein complexes as new structuring ingredients for meat replacers: effect of enzymatic treatments on gel structure

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Many plant-based foods consist of mixed biopolymer networks, where controlled interactions between components allow the design of specific mechanical and structural properties. In this study, we analyse the enzymatic crosslinking between wheat bran arabinoxylans (WBAX) and plant proteins, as a model for double network hydrogel formation. Ferulic acid residues in WBAX and amino acids such as tyrosine, cysteine, and tryptophan provide reactive sites for oxidative enzymes. We study how protein type, functional group availability, and enzymatic specificity influence the formation, structure, and viscoelastic behavior of arabinoxylan–protein networks, and evaluate the potential of WBAX–protein complexes as space-spanning networks, as well as suspended structures in model plant-based systems.

Plant proteins from pea, potato, faba, soy, and oat were crosslinked with laccase, peroxidase, or glucose oxidase in the presence of WBAX. Following incubation and heat treatment, the resulting gels were analyzed for rheological (time sweeps, temperature-dependency, and LAOS) and microstructural properties. Enzymatically treated samples showed higher viscoelastic moduli than untreated or single-component systems, indicating synergistic interactions and the formation of intermolecular WBAX–protein bonds. The effect was most pronounced in proteins with weak gelation, highlighting the potential of this approach to enhance their gelling performance. SDS-PAGE confirmed the formation of high-molecular-weight conjugates, while FTIR spectroscopy indicated strong hydrogen bonding between WBAX and all protein types. Confocal microscopy revealed interconnected network structures, which varied with ingredient ratio, WBAX ferulic acid content, and reaction conditions, reflecting the degree of crosslinking achieved.

In conclusion, the enzymatic crosslinking of plant proteins with WBAX caused a general increase in gel strength in all tested protein types. The extent of crosslinking was highly dependent on the ferulic acid content of WBAX and on the reaction conditions, while the gel structure was also affected by the ratio of the ingredients. Overall, we provide the foundation for the development of a new type of structuring systems for plant-based meat analogues.

Keywords:
Arabinoxylans, plant proteins, enzymatic texturization