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P.I.4 — Sequential enzymatic and hydrothermal fractionation of brewer's spent grain for selective prebiotic XOS production

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Poster Presentations #21

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The growing interest in functional food ingredients has intensified the search for sustainable sources of prebiotic xylooligosaccharides (XOS) with a low degree of polymerization (DP2–DP5). These compounds are particularly attractive due to their selective stimulation of beneficial gut microorganisms and their associated health benefits [1]. Yet, producing these compounds efficiently remains challenging, especially when working with complex lignocellulosic residues. Among agro-industrial residues, brewer's spent grain (BSG) is one of the most relevant. It accounts for approximately 85% of the total solid waste generated during beer production [2]—specifically during the mashing stage—and represents an abundant but underexploited feedstock. Although rich in hemicellulose, proteins, and phenolic compounds, its heterogeneous composition often limits its direct conversion into high-value fractions.

This study addresses these limitations by implementing a two-stage valorisation strategy designed to enhance BSG processability and maximise the selective release of XOS. First, a tailored enzymatic sequence—combining amylase, glucoamylase, and protease—was applied to remove starch and proteins, mitigating issues such as gel formation and Maillard-type reactions during thermal processing, and also allowing for the recovery of the protein. This step substantially increased the relative xylan content of the solid residue, creating a more suitable substrate for subsequent fractionation. The pretreated biomass was then subjected to liquid hot water processing at 185 °C, a catalyst-free approach that promotes controlled solubilisation and depolymerisation of arabinoxylans.

The integrated process yielded 13.8 g/L of XOS, corresponding to 8.7 g per 100 g of dry BSG, with nearly half of the recovered oligosaccharides falling within the low-DP range associated with enhanced prebiotic functionality. Degradation products remained minimal, highlighting the selectivity of the method. Beyond XOS, the process generated additional streams of biotechnological interest, including protein- and sugar-rich liquors and a cellulose-enriched solid fraction with improved digestibility.

Overall, this work demonstrates that BSG can be transformed from a low-value residue into a versatile feedstock for producing high-quality prebiotic ingredients, reinforcing its role within advanced biorefinery and circular-economy strategies.

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