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Adaptative Metabolism of Lactic Acid Bacteria during Brewers' Spent Grain Fermentation

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Abstract : Demand for smart management of large amounts of agro-food by-products has become an area of major environmental and economic importance worldwide. Brewers' spent grain (BSG), the most abundant by-product generated in the beer-brewing process, represents an example of valuable raw material and source of health-promoting compounds. To the date, the valorization of BSG as a food ingredient has been limited due to poor technological and sensory properties. Tailored bioprocessing through lactic acid bacteria (LAB) fermentation is a versatile and sustainable means for the exploitation of food industry by-products. Indigestible carbohydrates (e.g., hemicelluloses and celluloses), high phenolic content, and mostly lignin make of BSG a hostile environment for microbial survival. Hence, the selection of tailored starters is required for successful fermentation. Our study investigated the metabolic strategies of Leuconostoc pseudomesenteroides and Lactobacillus plantarum strains to exploit BSG as a food ingredient. Two distinctive BSG samples from different breweries (Italian IT- and Finish FL-BSG) were microbially and chemically characterized. Growth kinetics, organic acid profiles, and the evolution of phenolic profiles during the fermentation in two BSG model media were determined. The results were further complemented with gene expression targeting genes involved in the degradation cellulose, hemicelluloses building blocks, and the metabolism of anti-nutritional factors. Overall, the results were LAB genus dependent showing distinctive metabolic capabilities. Leuc. pseudomesenteroides DSM 20193 may degrade BSG xylans while sucrose metabolism could be furtherly exploited for extracellular polymeric substances (EPS) production to enhance BSG pro-technological properties. Although L. plantarum strains may follow the same metabolic strategies during BSG fermentation, the mode of action to pursue such strategies was strain-dependent. L. plantarum PU1 showed a great preference for β-galactans compared to strain WCFS1, while the preference for arabinose occurred at different metabolic phases. Phenolic compounds profiling highlighted a novel metabolic route for lignin metabolism. These findings will allow an improvement of understanding of how lactic acid bacteria transform BSG into economically valuable food ingredients.

Keywords : brewery by-product valorization, metabolism of plant phenolics, metabolism of lactic acid bacteria, gene expression
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