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Co-Synthesis of Exopolysaccharides and Polyhydroxyalkanoates Using Waste Streams: Solid-State Fermentation as an Alternative Approach

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Abstract : Bioplastics are gaining attention as potential substitutes of conventional fossil-derived plastics and new components of specialized applications in different industries. Besides, these constitute a sustainable alternative since they are biodegradable and can be obtained starting from renewable sources. Thus, agro-industrial wastes appear as potential substrates for bioplastics production using microorganisms, considering they are a suitable source for nutrients, low-cost, and available worldwide. Therefore, this approach contributes to the biorefinery and circular economy paradigm. The present study assesses the solid-state fermentation (SSF) technology for the co-synthesis of exopolysaccharides (EPS) and polyhydroxyalkanoates (PHA), two attractive biodegradable bioplastics, using the leftover of the brewery industry brewer's spent grain (BSG). After an initial screening of diverse PHA-producer bacteria, it was found that Burkholderia cepacia presented the highest EPS and PHA production potential via SSF of BSG. Thus, B. cepacia served to identify the most relevant aspects affecting the EPS+PHA co-synthesis at a lab-scale (100g). Since these are growth-dependent processes, they were monitored online through oxygen consumption using a dynamic respirometric system, but also quantifying the biomass production (gravimetric) and the obtained products (EtOH precipitation for EPS and solid-liquid extraction coupled with GC-FID for PHA). Results showed that B. cepacia has grown up to 81 mg per gram of dry BSG (gDM) at 30°C after 96 h, representing up to 618 times higher than the other tested strains' findings. Hence, the crude EPS production was 53 mg g-1DM (2% carbohydrates), but purity reached 98% after a dialysis purification step. Simultaneously, B. cepacia accumulated up to 36% (dry basis) of the produced biomass as PHA, mainly composed of polyhydroxybutyrate (P3HB). The maximum PHA production was reached after 48 h with 12.1 mg g^{-1}DM, representing threefold the levels previously reported using SSF. Moisture content and aeration strategy resulted in the most significant variables affecting the simultaneous production. Results show the potential of co-synthesis via SSF as an attractive alternative to enhance bioprocess feasibility for obtaining these bioplastics in residue-based systems.

Keywords : bioplastics, brewer’s spent grain, circular economy, solid-state fermentation, waste to product
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