Brewer's spent grain valorisation for the production of microbial oil via fermentation and extraction of value added co-products through biorefinery development

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Brewer's spent grain (BSG) is produced at high quantities at the brewery industry. In 2014, the worldwide production of beer from barley was 180.3 million tons, according to FAOSTAT. During the last five years, Asia (33.5%), Americas (31%) and Europe (27.9%) hold the world production share, with the top producing countris being, Chin, mainland (47.1 million tons), USA (22.8 million tons), Brazil (12.9 million tons), Germany (8.8 million tons) and Mexico (8.5 million tons). The brewing process involves barley malting (steeping, germination and drying or kilning). Malted barley is then milled and mixed with water at the appropriate temperature to induce enzymatic hydrolysis of starch to glucose and also proteins, glucans and arabinoxylans, resulting in soluble sugars and nitrogen compounds. Among the by-products that are produced during the brewing process (spent grain, trub, spent hops, spent yeast and diatomaceous earth slurry from filtration), BSG is 85% w/w. BSG is rich in cellulose, non-cellulosic polysaccharides and lignin, protein and lipids (main components of walls of the husk–pericarp–seed coat). The husk also contains considerable amounts of polyphenolic components.

Industrial waste can be exploited for biorefinery development and the production of bio-based chemicals and polymers. The significant content in polyphenolic components, renders BSG a natural source of antioxidants that could be applied in food or non-food (adhesives, resins, plastics, rubber) applications. Also high protein content (25 % w/w) and lipid content (10 % w/w) could lead to a versatile industry producing various value added co-products. Protein extract could be used as food and feed additive, or non-food applications. The remaining fraction, rich in polysaccharides, can be used for the production for microbial oil. In this study, BSG was used for the extraction of antioxidants, proteins and lipids. Polysaccharides were hydrolysed through chemical and enzymatic hydrolysis and the sugars were used for microbial oil production. Sugar production from BSG was evaluated via enzymatic hydrolysis leading to release of hemicellulose derived sugars and glucose from cellulose hydrolysis. Batch and fed-batch fermentations were carried out for microbial oil production using *Lipomyces starkeyi*.