Proceedings of the 9th World Congress on New Technologies (NewTech'23)
Brunel University, London, United Kingdom - August 09-11, 2023
Paper No. ICEPR 110
DOI: 10.11159/icepr23.110

Biotransformation of Brewing By-Products To Reduce The Current Food Waste And Relieve Associated Environmental Pollution

Jiao Zhang[1], Ariane Perez-Gavilan[1], Adriana Cunha Neves[1]
[1]South East Technological University, EnviroCORE research group
Kilkenny Campus, Carlow, Ireland
jiaozhang@itcarlow.ie; ariane.perezgavilan@setu.ie; adriana.cunhaneves@setu.ie

Extended Abstract

In the food industry, the brewing industry holds an important economic place with world beer production exceeding 1.82 billion hectolitres in 2020, of which Europe attributed 500.93 million hL [1]. An hL of beer results in 20 kg of wet brewers spent grain (BSG) [2], which means that 2020 resulted in 36.4 million tons of wet BSG globally. As the largest waste by volume, brewers' spent grain (BSG) represents around 85% of the total brewing waste generated [3]. Yet, approximately 70% of BSG is used as animal feed, but due to its high moisture content (~ 75%) and microbial load, its shelf life is extremely short - less than 48 hours [4]. Around 10% of spent grain is converted into biogas, while the remaining 20% is landfilled [4]. Every tonne of BSG disposed of in a landfill emits 513 kg of CO_2 equivalent to greenhouse gases [4], violating sustainability principles and can trigger serious environmental problems. However, this brewing "waste" has an exceptional circular economy and nutritional potential as its high protein content (16 ~ 28%) nature which has been shown to have valuable bioactivities, making it an ideal candidate for upcycling into the human food supply, feed, or pharmaceutical purposes [5]. Meanwhile, over 800 million people are suffering from hunger in low-income countries and these functional resources are being wasted [6]. Thus, owing to the significant amount produced annually, current low market value, increasing environmental awareness, and the recognition that BSG may represent a nutritionally valuable co-product, efforts should be increasingly focused on the valorisation of this agro-industrial by-product.

To meet the current concept of sustainable and green development, this study aims to determine whether brewing industry waste products have the potential to be used as the source of natural, functional, sustainable bioactive proteins and peptides, and to explore the potential applications of the resulting extracts in the food industry. Due to the fact that plant proteins are easily soluble in an alkaline environment and precipitate under acidic isoelectric conditions, the pH adjusting method was adopted as the protein recovery approach [3]. Besides, this research compares the extraction methods, physicochemical characteristics and bioactivity properties of hydrolysates generated from BSG protein. The extraction of protein via the direct alkaline solubilization method and the Cellulase pre-treatment method was not significantly different in terms of extraction yield. This demonstrates that the direct alkaline extraction method is a less resource-intensive process and will be adopted for BSGP extraction in future studies. This result is significantly important from the industrial processing perspective as it is considerably more relevant in terms of production cost and energy consumption. The intact protein displayed significantly higher ACE-inhibitory activities and antioxidant properties than their associated enzymatic hydrolysates (Max ACE inhibition of 73.95 ± 0.01% and Max antioxidant activity of 844.63 ± 11.12 μM). The finding revealed that the BSGP already exhibited relatively high biological activity without further enzymatic hydrolysis and is the potential to be used as a source of bioactive proteins or peptides. These results are particularly valuable to the industry since the direct extraction of bioactive BSGP without hydrolysing can shorten the production time, decrease solvent consumption, improve the utilization of protein in the residue and reduce the waste of resources and environmental pollution.

References

[1] S. (2021), "Beer Production Worldwide in 2020, by Region (In Million Hectoliters)," 2021. [Online]. Available: https://www.statista.com/statistics/202417/beer-output-volumes-of-the-different-continents-in-2010/.

[2] K. M. Lynch, E. J. Steffen, and E. K. Arendt, "Brewers' spent grain: a review with an emphasis on food and health," *Journal of the Institute of Brewing,* vol. 122, no. 4, pp. 553-568, 2016, doi: 10.1002/jib.363.

[3] J. Zhang, A. Perez-Gavilan, and A. C. Neves, "Evaluation of the In Vitro Bioactivities Profiles of Brewers' Spent Grain Protein and Hydrolysates with and without Cellulase Pretreatment," *Nutraceuticals,* vol. 2, no. 3, pp. 218-233, 2022. [Online]. Available: https://www.mdpi.com/1661-3821/2/3/16.

[4] E. Commission. "New Strategies for Improving the Sustainability of Breweries: Full Waste Recovery for Aquaculture Feed." https://webgate.ec.europa.eu/life/publicWebsite/index.cfm?fuseaction=search.dspPage&n_proj_id=6266#:~:text=The%20largest%20waste%20by%20volume,the%20remaining%2020%25%20is%20landfilled. (accessed).

[5] R. Garrett, D. Bellmer, W. McGlynn, and P. Rayas-Duarte, "Development of New Chip Products from Brewer's Spent Grain," *Journal of Food Quality,* vol. 2021, 2021.

[6] "World Hunger: Key Facts and Statistics 2021." https://www.actionagainsthunger.org/world-hunger-facts-statistics (accessed.