Production of Highly Fermentable Dietary Fibers from Brewer's Spent Grains Treated with Aqueous Ammonia

Hongchen Shen, Journey Yang, Haibo Huang*

Department of Food Science and Technology, Virginia Polytechnic Institute and State University, 1230 Washington Street SW, Blacksburg, VA, 24061, USA

* Corresponding author: huang151@vt.edu

Brewer's spent grain (BSG) is one of the most abundant by-products of the brewing industry, with approximately 39 million tons produced annually worldwide. Rich in bioactive compounds such as phenolic acids, proteins, and carbohydrates, BSG holds considerable potential for value-added applications. However, due to its highly perishable nature, the majority of BSG is currently discarded or used as low-value animal feed, resulting in economic losses and environmental concerns. In response, the growing interest in the circular bioeconomy has driven efforts to develop effective strategies for BSG valorization.

Among its components, dietary fibers are of particular interest for the development of prebiotic dietary ingredients. However, as a lignocellulosic material, the presence of recalcitrant lignin in BSG limits the accessibility and fermentability of these fibers by gut microbiota. Compared to conventional biomass pretreatment methods such as steam explosion, soaking in aqueous ammonia (SAA) offers a selective delignification approach that preserves most hemicellulose. This makes it a promising strategy for producing highly fermentable dietary fibers. Therefore, this study aims to investigate the impact of SAA treatment on the chemical composition, functional properties, and *in-vitro* fermentability of dietary fibers derived from BSG.

BSG was treated with aqueous ammonia solutions (15 wt% and 30 wt%) at a solid-to-liquid ratio of 1:10, at temperatures of 50 °C and 70 °C for 48 hours. Following pretreatment, the BSG was thoroughly washed with deionized water until the pH approached neutral, and then oven-dried at 60 °C overnight. Chemical composition analyses were conducted to compare the pretreated and untreated BSG, revealing changes in lignin, hemicellulose, and cellulose content resulting from the SAA treatment. A series of characterization techniques, including FTIR and SEM, were employed to characterize both treated and untreated samples. The *in-vitro* gut fermentability of the dietary fibers derived from BSG was evaluated using swine fecal fermentation, with short-chain fatty acid (SCFA) production monitored as a key indicator. Preliminary results indicate that the SAA treatment effectively disrupts the inert, compact structure of native BSG and exposes fermentable hemicellulose. Compositional analysis confirmed that SAA retained most of the hemicellulose in BSG. Furthermore, BSG treated with 30% aqueous ammonia at 70 °C exhibited the highest fermentability among all samples, with butyric acid and propionic acid concentrations exceeding 200% of those from untreated control, and acetic acid concentration increasing by 1.5-fold.

This study presents a novel strategy for producing highly fermentable prebiotic dietary fibers from BSG and establishes a correlation between fermentability and hemicellulose content. The results pave the way for the future valorization of this agricultural by-product.