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学位論文内容の要旨

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学位論文題名

Route exploration of valorization of buckwheat waste based on subcritical liquid treatment

（亜臨界液体処理によるソバ廃材の付加価値化方法に関する検討）

Buckwheat waste (BW), which includes husks, leaves, and straw, is usually thrown away or burned. This leads to serious pollution problems and a waste of resources. BW is rich in cellulose, hemicellulose, antioxidants, and various sugars; thus, it can be considered as a potential source for improving the economic benefits of buckwheat cultivation. However, components such as sugars and antioxidants in BW are often cross-linked with structural compounds via chemical bonds. Therefore, it is vital to develop a strategy to facilitate depolymerization of these structures and improve the utilization efficiency of BW.

In this study, subcritical water has been developed to improve the yields of saccharides from BW. Subcritical ethanol solution was used to increase the yields of bioactives components. Then scaling up to an industrial level was tested on a pilot scale. The hydrolysate collected from subcritical seawater treatment of BW has also been tried as a liquid fertilizer to promote lettuce growth.

1. Subcritical water treatment of buckwheat waste for sugar extraction

A subcritical water treatment (SWT) was chosen for cellulose and hemicellulose degradation to produce saccharides from raw BW. The sum of saccharides yields in the liquid sample were compared. A higher sum of saccharides yields of 4.10 % was obtained at a relatively lower severity factor of 3.24. The contents of cellulose, hemicellulose, and lignin were analyzed in the residue after SWT. The result shows that lignin was dominant in the residue. The irregular pores were observed by SEM after SWT due to the removal of some hemicellulose, and lignin. Finally, an overall mass conversion base on saccharides production was carried out. The result reflects a considerable yield of saccharides from BW by SWT.

2. Buckwheat waste depolymerization using a subcritical ethanol solution for extraction of bioactive components: from the lab to pilot scale

Subcritical ethanol solution treatment (SEST) was used to depolymerize BW and extract bioactive components such as phenolics, flavonoids, and sugars on both the lab and the pilot scale. On the lab scale, various treatment conditions were compared. Depolymerization of the microstructure was evaluated by detecting solid components, and the extraction of bioactive compounds was studied by detecting liquid components. The mechanism of SEST depolymerization of BW and extraction of bioactive components is discussed. Scaling up to an industrial level was tested on a pilot scale, and solid and liquid components were identified. The total phenolics content increased significantly because SEST promoted the degradation of lignin and the solubilization of extractives. The yield of total flavonoids did not change significantly with increases in the temperature, which could be attributed to degradation of some flavonoid components at high temperature. Reducing sugars were mainly in the form of polysaccharides, which was attributed to the low temperature. The maximum total yields of phenolics, flavonoids, and reducing sugars were 29.8 ± 0.1, 13.9 ± 0.5 and 33.9 ± 0.5 g/kg, respectively. This study provides valuable reference data for BW utilization on a pilot scale.

3. Effect of hydrolysate from subcritical seawater treatment of buckwheat waste as liquid fertilizer on lettuce growth

BW was treated with subcritical seawater treatment (SST) at different treatment temperatures. The collected hydrolysate was used as a liquid fertilizer for lettuce growth, and finally the physico-chemical properties of hydrolysate and the growth indexes of lettuce under each condition were examined. The results showed that after SST of BW, the salt content decreased with some antioxidants and sugars increased of the hydrolysate. The hydrolysate was able to promote the growth of lettuce. The maximum weight of lettuce cultivated in the hydrolysate was 22 g, with an average height of 14 cm at 170℃ of SST. This study combined the reuse of biomass and seawater for agricultural cultivation, which provided a new way to use BW, it acts as a reference for the irrigation of seawater in agricultural cultivation, and also increased the added value of buckwheat cultivation.