# Resources in Urban Systems to Produce Sustainable Feedstocks for Precision Fermentation

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## Introduction

Precision fermentation (PF) is a biotechnological solution that is water-intensive and requires high volume of carbon source. Current feedstocks for PF remains to rely heavily on the agricultural food crops, creating additional $CO_2$ emissions and competition for natural resources (land, water, mined minerals). To mitigate this issue, sustainable feedstocks derived from lignocellulosic agricultural wastes such as grain straws, sugarcane bagasse and husks are often proposed. However, for urban systems such as Singapore, access to these resources from neighboring countries would be logistically inefficient. Based on the 3 essential ingredients of a fermentation feedstock: (1) carbohydrates, (2) nitrogen source, (3) phosphorus source, our work began with profiling examples of sidestreams that are available in urban systems to produce sustainable feedstocks.

## Sidestreams Explored

In Singapore, soymilk production is a $25 million industry with annual okara volume of over 7000 tonnes, and daily soy processing water volume of 3600 L from a single local soymilk producer. Beer production is a $9 billion industry with annual brewers' spent grains (BSG) volume of over 80,000 tonnes. Their high volume and low economic value makes them cost-efficient resources for fermentable nutrients to serve as PF feedstocks.

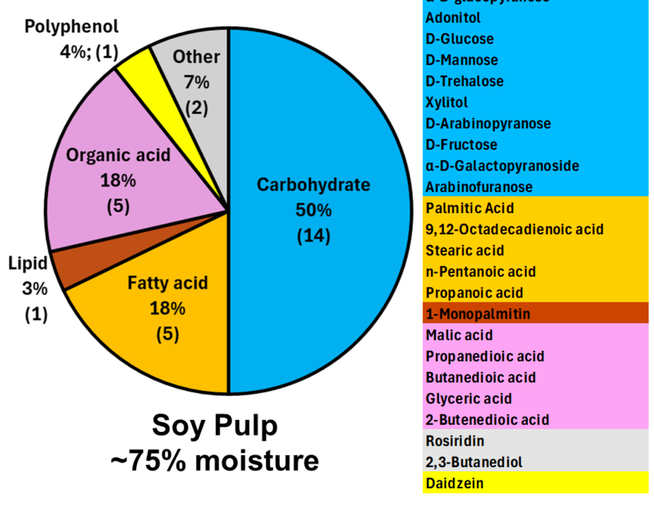

**OKARA (SOY PULP)**


**SOY PROCESSING WATER**

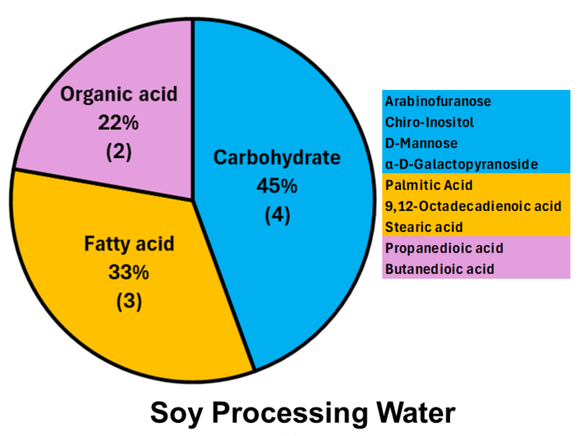
**BREWER'S SPENT GRAINS**

## Compositional Analyses

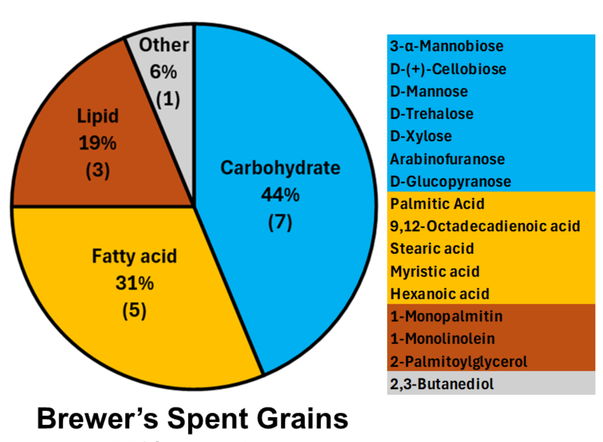
### GC Analyses




**Soy Pulp ~75% moisture**

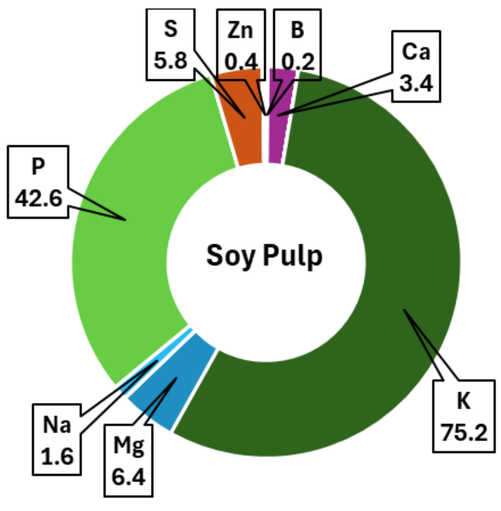


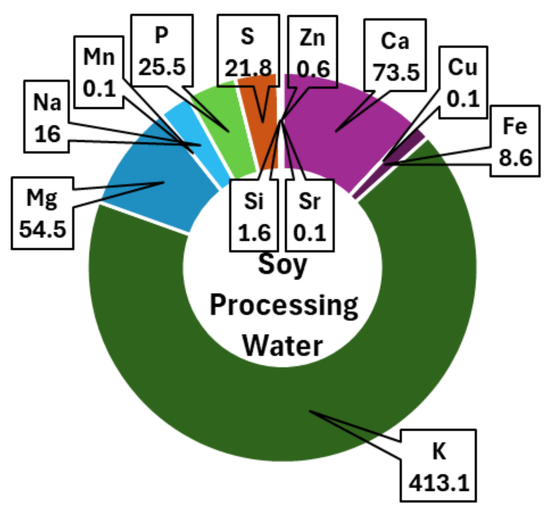

**Soy Processing Water > 99% water**

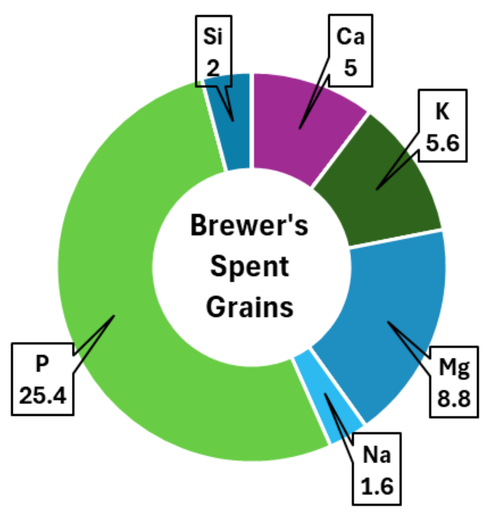



**Brewer's Spent Grains ~75% moisture**

### ICP-OES Analyses

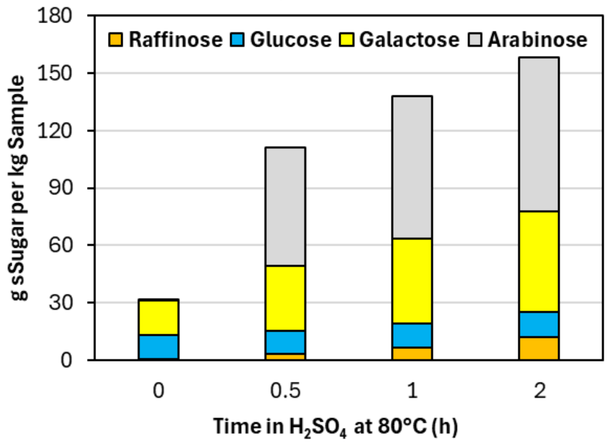


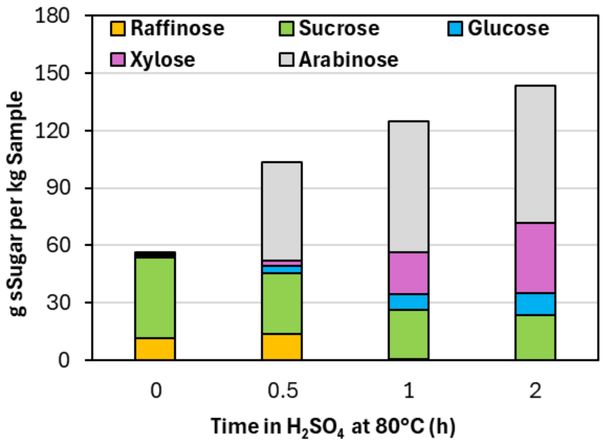



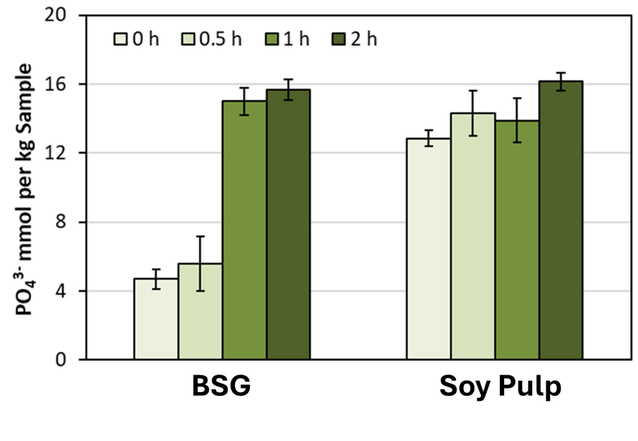

### Carbohydrate & Phosphates Content

**Soy Pulp**




**BSG**




## Discussion & Conclusion

Global profiling of the soy pulp, soy processing water and brewer's spent grains (BSG) reveals a substantial presence of carbohydrates, trace elements and essential nutrient like phosphates, which are relevant for utilization in PF. Acid hydrolysis potentially liberated xylose and arabinose from the hemicellulose structures. Enzymatic hydrolysis would be ideal to release higher amount of glucose from the cellulose structures. To date, majority of the homogenous sidestreams from the food industry in Singapore such the soymilk and beer production are valorized into animal feed. These findings demonstrate the feasibility in redirecting these resources towards higher value valorization pathways, in this case, to be recycled for fermentable nutrients that can alleviate PF reliance on agricultural food crops.

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This research is supported by the National Research Foundation, Prime Minister's Office, Singapore under its Campus for Research Excellence and Technological Enterprise (CREATE) programme.