

## Valorization of brewer's spent grain by furfural recovery/removal from subcritical water hydrolysates by pervaporation

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Lignocellulosic biomass is one of the most attractive options to achieve sustainable production of energy and chemicals as substitutes for petroleum-based products. The brewing industry most important by-product is the brewer's spent grains (BSG), accounting about 85 % of the total by-products [1]. It presents a valuable chemical composition with a high content of protein and carbohydrates and a significant source of phenolic compounds. Among the different technologies proposed to valorize lignocellulosic biomass, subcritical water (subW) has been chosen to fractionate the biomass into its individual building blocks by hydrolysis [1]. One of the top value-added products that can be obtained is furfural, produced by the dehydration of pentoses, present in the hemicellulose fraction of lignocellulosic biomass. For the recovery of this valuable compound, pervaporation is the proposed membrane separation process. Two different organophilic dense membranes were tested in this study: (1) polydimethylsiloxane (PDMS) (2) polyoctylmethyl siloxane (POMS).

SubW hydrolysis treatment was carried out in a laboratory-scale batch stainless-steel reactor of 0.5 L capacity. Pressure was fixed at 50 bar by using nitrogen gas. SubW hydrolysis was carried out at 175 °C for 60 min and a biomass loading of 5 % (w/v). The main monomeric sugar released to the hydrolyzed medium was xylose, and the main sugars degradation product was furfural (from 1.3 to 1.7 g·L<sup>-1</sup>). Organic acids were also determined, being acetic and formic acids, the major organic acids found.

Furfural was the main compound from subW hydrolysates that could be selectively removed by organophilic PV membranes. Its recovery was studied at a 55.5 ± 0.5 °C, and a permeate pressure of 300 Pa.

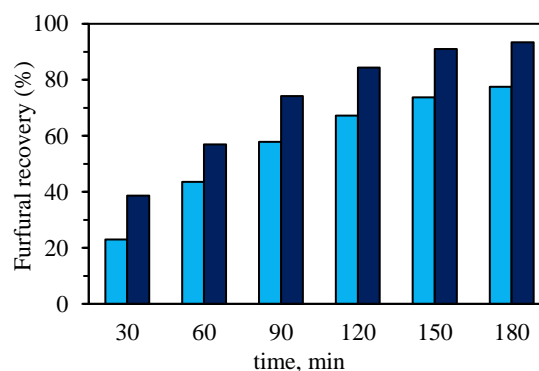
After 180 min of PV, POMS membrane reached a furfural recovery of 93 %, while 78 % was obtained for PDMS membrane (Figure 1). Furfural concentration was 0.35 g·L<sup>-1</sup> and 0.17 g·L<sup>-1</sup> in the retentates after PDMS and POMS pervaporation, respectively, from initial feeds of 1.7 and 1.3 g·L<sup>-1</sup>. Medium values for furfural concentration in the permeate were 21 and 9 g/L for POMS and PDMS, respectively. Furthermore, both membranes showed the highest enrichment factor towards furfural when compared to other organic acids present in the subW hydrolysates, proving their selectivity towards this component.

This work has shown that the selective recovery of furfural, as a biomass-derived platform chemical, from subW hydrolysates could be successfully achieved by pervaporation using organophilic membranes, and that is an efficient technology to be incorporated in a biorefinery process, after the subW pretreatment of BSG.

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### References

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<https://doi.org/10.1016/j.foodchem.2021.129264>



**Figure 1.** Furfural recovery in the permeate for PV of BSG hydrolysates for each membrane (■ PDMS ■ POMS) over PV time.