Responsible, low-cost disposal or reuse of by-products from food manufacture: Sustainable uses for spent brewer's grain from microbreweries

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Introduction

Brewer's spent grain (BSG) is a by-product of the brewing process, accounting for approximately 85% of total waste (Mussatto, 2014). The number of microbreweries operating in the UK has grown by 10% per annum over the last two years (ONS, 2015), but as microbreweries are often small-scale enterprises, they do not have a comprehensive BSG disposal plan.

Aim

The aim of this project is to determine suitable uses of brewer's spent grain that can be implemented with little cost by a microbrewery, to improve the sustainability of their brewing operations. This addresses the gap of BSG usage specifically from microbreweries.

Methodology

1) Drying

Drying increases the BSG lifetime before spoilage and reduces transport costs. The low-cost method of mechanical pressing by using a hand-operated screw press is chosen, followed by ambient tray drying – drying with no dedicated heat or air movement source.

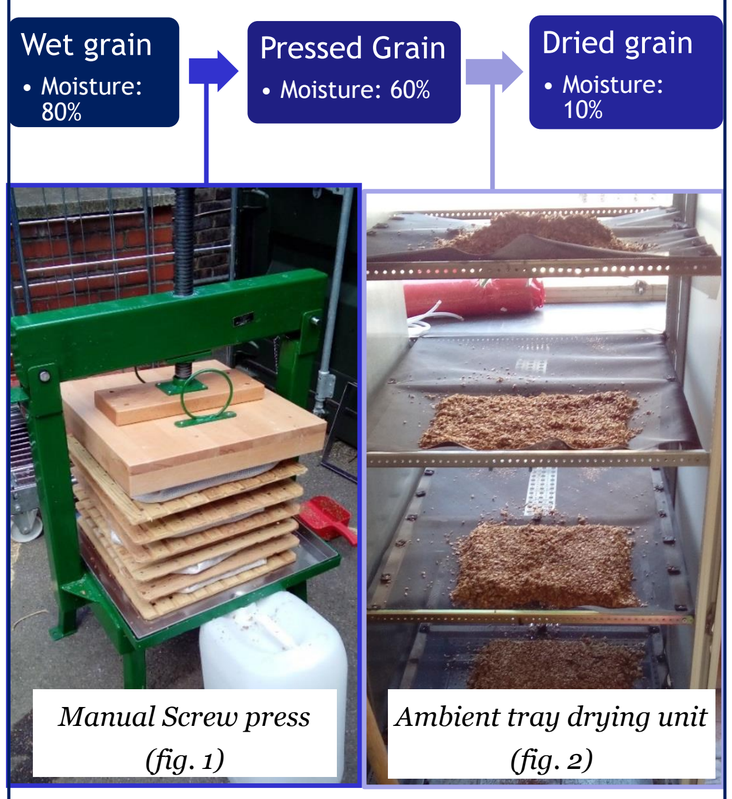
2) Anaerobic Digestion (AD)

The liquid fraction from pressing the grain is assessed for its biochemical methane potential as an anaerobic digestion feedstock, and compared with BSG. The method used is a batch biochemical methane potential assay.

References

Mussatto, S.I. (2014) 'Brewer's spent grain: a valuable feedstock for industrial applications', *Journal of the Science of Food and Agriculture*, 94(7), pp. 1264-1275.
ONS (2015) 'E-cigarettes and craft beer added to the CPI basket of goods' Statistics. 17 March 2015. Office for National Statistics 2.

Drying

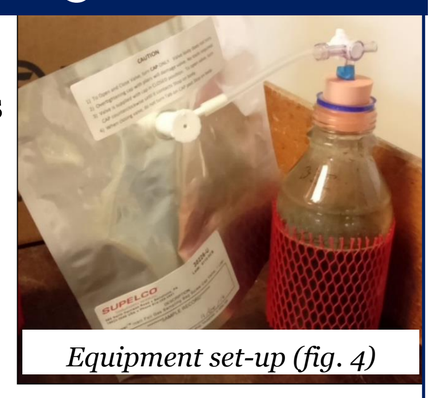


Manual Screw press (fig. 1)

Ambient tray drying unit (fig. 2)

Anaerobic Digestion

- AD performed at 37°C in 4 sets of triplicates (see below).
- Methane conc. and volume sampled daily by GC and syringe, respectively.



Equipment set-up (fig. 4)

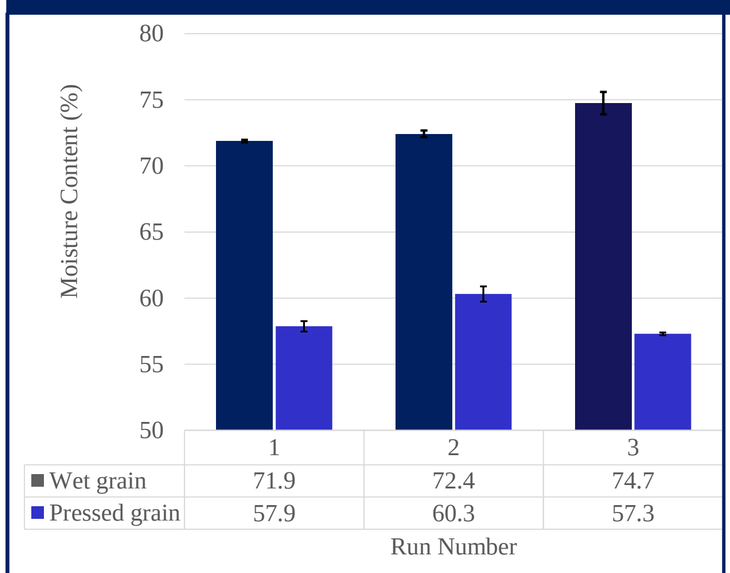
1) Blank Control
- Inoculum only
- Provides baseline gas production

2) Positive Control
- Inoculum & starch
- Indicator of inoculum quality

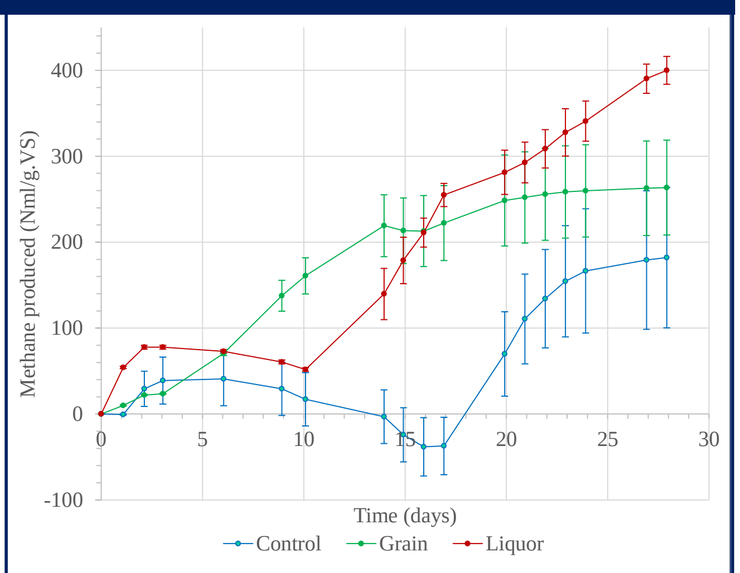
3) Wet grain

4) Pressing liquor

Results



Screw press moisture reduction (fig. 3)



Substrate methane potential (fig. 5)

- Screw pressing reduced the moisture content of BSG from 73.0 ± 0.7% to 58.5 ± 0.8%, hence reducing the mass by over 38% (fig. 3).
- Drying was quickest with the shallowest 2cm layer that was turned regularly and reached equilibrium moisture content in 40 and 75 hours for replicates.
- Equilibrium moisture content was found to be 9-11% dependant on the ambient room conditions.

- The methane potential of pressing liquor and BSG was 405 ± 17 ml.g_{VS}^{-1} and 335 ± 45 ml.g_{VS}^{-1} after 28 days, but the liquor max. potential is unreported as gas was still being produced.
- The liquor exhibited diauxic production, likely due to inhibition from the products of rapidly digested sugars present.
- The average methane concentrations across the grain and liquor assays were 48.0% and 57.7% respectively.

Conclusions

- ❖ Differences in ambient temperatures and humidity cause significant variation in drying times.
- ❖ Ambient tray drying is feasible although a large area is required for it to be effective.

- ❖ The spent grain pressing liquor is an attractive AD substrate, with high conversion.
- ❖ AD of liquor may have limited practical applications due to the relatively low volumes pressed from the BSG.