BREWERY RECYCLING:
NEW PROCESS CONVERTS SPENT BREWERY GRAINS INTO BEER YEAST

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As the business of craft brewing becomes more and more competitive, economics are taking an equal priority to artistry. More than success, mere survival in today's malt beverage marketplace requires a business model that reduces every conceivable cost so that craft brewing ventures can continue to create both brands and profits.

Recycling and the maximization-of-efficiencies always have been key ingredients in the craft brewer's business recipe. Spent grains, the leftover malt and adjuncts after the mash has extracted most of the sugars, proteins, and nutrients, can constitute as much as 85 percent of a brewery's total by-product. For decades, craft breweries across America have devised innovative ways to prevent their spent grain from going to waste. Examples include composting, fertilizer for growing mushrooms, adjunct ingredients for baking and bread-makers, use by ranchers and dairymen as stock feed, use by chicken and other poultry farmers as flock feed, and even use as filler in the production of dog treats.

While agricultural uses of spent grain predominate, few of these re-uses produce actual value for the craft brewer. Occasionally, recipients are willing to pay a nominal fee for receipt of spent grains. In most cases, however, the brewer is happy to donate these byproducts in the true spirit of recycling.

However, a new waste-to-nutrient technology suggests that a big change lies ahead in terms of the options available to brewers for spent grains.

Scientists from Nanyang Technological University, Singapore (NTU) recently announced the discovery of a new process that transforms spent brewery grains into a valuable liquid nutrient that can grow beer yeast. The new process has sufficient promise that Asia Pacific Breweries reportedly is in talks with the NTU scientists to explore whether the process can be

commercialized to make breweries more sustainable by (i) reducing their waste footprint, while (ii) repurposing spent grains to produce a value-added product that can contribute materially to the brewery's bottom line.

NTU's research findings were published recently in AMB Express, a peer-reviewed scientific journal in the area of applied and industrial microbiology by SpringerOpen.[1] According to the paper's abstract:

> Brewers' spent grain (BSG) is a by-product generated from the beer manufacturing industry, which is extremely rich in protein and fiber. Here we use low cost BSG as the raw material for the production of a novel growth media, through a bioconversion process utilizing a *food grade fungi* to hydrolyze BSG. The novel fermentation media was tested on the yeast *Rhodosporidium toruloides*, a natural yeast producing carotenoid. The yeast growth was analysed using the growth curve and the production of intracellular fatty acids and carotenoids. Untargeted GCMS based metabolomics was used to analyse the constituents of the different growth media, followed by multivariate data analysis. Growth media prepared using fermented BSG was found to be able to support the growth in *R. toruloides* (21.4 mg/ml) in comparable levels to YPD media (24.7 mg/ml). Therefore, the fermented BSG media was able to fulfill the requirement as a nitrogen source for *R. toruloides* growth. This media was able to sustain normal metabolomics activity in yeast, as indicated by the level of fatty acid and carotenoid production. This can be explained by the fact that, in the fermented BSG media metabolites and amino acids were found to be higher than in the unfermented media, and close to the levels in YPD media. Taken together, our study provided evidence of a growth media for yeast using BSG. This should have potential in replacing components in the current yeast culture media in a sustainable and cost effective manner.

Repurposing Spent Grains

In brewing, yeast is the key ingredient for fermentation, a process where sugars from the grains are converted into alcohol. The production of malt beverages on a commercial level typically requires large amounts of yeast.

When grains such as barley or hops are fermented by yeast, the grain's sugars, protein and nutrients will be stripped, leaving behind plant fibers known as "lignin." While lignin is tough and generally unusable in food production, certain types of microorganisms are able to break lignin down into smaller, nutritious components. These nutritious components can then be mashed and turned into a liquid, which is easily digestible by brewing yeasts.

For those craving a more detailed scientific explanation, the paper published by the NTU scientists explained that fermented brewers' spent grains (BSG) growth media showed exceptionally better growth of the brewery yeast *Rhodosporidium toruloides* (a natural yeast

[1] Wei Ning Chen, Sachindra T. Cooray and Jaslyn J. L. Lee, "Evaluation of brewers spent grain as a novel media for yeast growth," *AMB Express* 7:117 (2017). This paper is accessible in its entirety online at: https://doi.org/10.1186/s13568-017-0414-1 (Last accessed on September 4, 2017).

producing carotenoid) compared to unfermented BSG growth media, and showed similar growth patterns when compared with other yeast media. However, because the NTS scientists found that fermented BSG media only fulfilled the nitrogen requirement for yeast growth and had to be supplied with an external carbon source (2% w/w glucose), they concluded that the prior bioconversion process was an essential step to release the nutrients from BSG. Thus, the fermentation on the BSG is presumed to hydrolyze proteins into peptides and amino acids due to the production of proteases by the fungi growth. Hence, according the NTS study, the bioconversion associated with brewing grains helps to break down the BSG proteins and increases their nitrogen content.

Science is important, but so is economics. Spent grain amounts to as much as 85 percent of a brewery's waste. NTU's conversion process turns brewer's waste into a valuable liquid nutrient. Similar commercial liquid nutrients commonly sell for $50 - $100 per gallon. In contrast, NTU's technology uses food-grade microorganisms to convert a brewery's spent grains into basic nutrients that can be readily consumed by brewing yeast at a fraction of the cost.

Approximately 50 million gallons of beer were produced worldwide in 2016, which, generated approximately 250,000 tons of spent grains. Every gallon of beer produces approximately ten pounds of spent grains. Do the math, and the economics could prove revolutionary.

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