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2014 ASBC Annual Meeting

Value Added Processing of Brewery Wastes

for Production of Feed, Fuel and Fertilizer Utilizing Larvae and Algae

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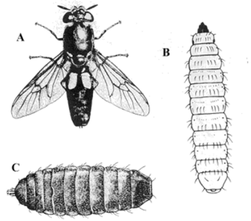
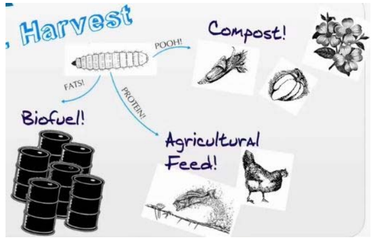
Introduction:
Clemson University Biosystems Engineering and Creative Inquiry programs collaborate in the area of "innovations in brewing". Projects have ranged from regional cultivars of hops, grains and yeast, nanobrewery design, heat recovery optimization, life-cycle assessment of regional ingredients and recovery of value added products from brewery wastes. This study examines the use of larvae and algae for the bioconversion of spent grains, trub and yeast slurry into lipids, organic soil amendments, and natural protein meal.

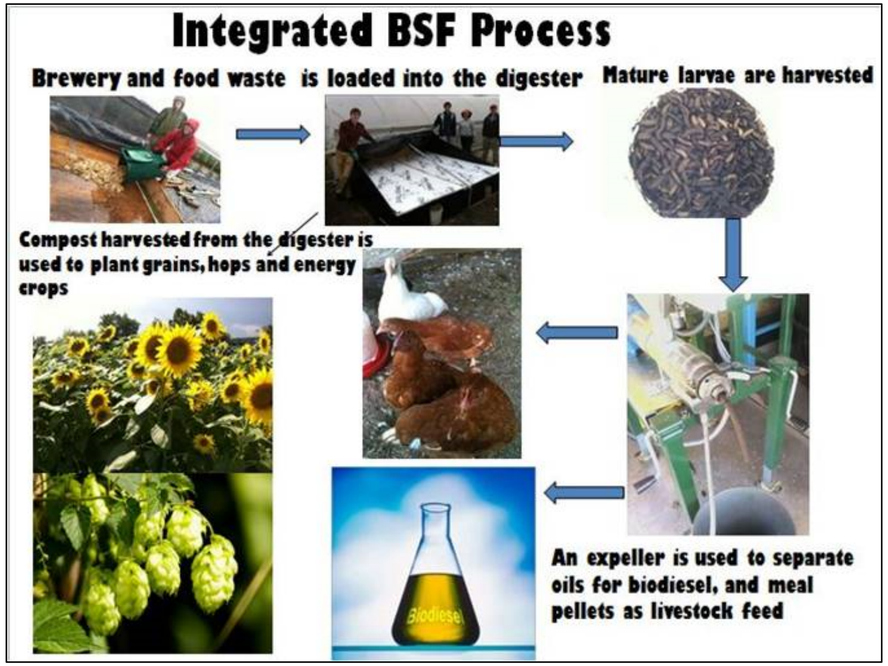
Background:
Hermetia illuscens, the black soldier fly (BSF), is ubiquitous throughout North America and a voracious consumer of decaying nitrogenous material. Larvae of BSF are capable of consuming 5 times their body weight daily under ideal conditions. Pre-pupae of the BSF migrate from feeding bins, called black soldier fly digesters (BSFD) after approximately 3 weeks of digestion of substrate. Controlled migration by the design of the BSFD enables labor-less self-harvest of the mature pre-pupae at optimal stage of growth for the purpose of extracting oils and proteins from the larvae.

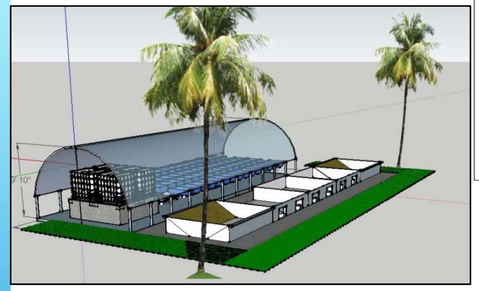


Black soldier fly. A, Adult female. B, Larva. C, Puparium.



Method:
The Brewcovery ™ process uses a specially designed BSFD for easy loading, energy efficiency, self-harvest and season extension via integrated greenhouse design. Harvested larvae are dried, then pressed for expulsion of oils for biodiesel production. BSF pre-pupae are on average 35% lipid. Remaining biomass after oil expulsion is pelletized. These pellets contain 42% protein, 5% calcium and a host of micronutrients ideal for fish and poultry. Meal pellets are fed as single source food for tilapia, while a blend of 70% sunflower meal and 30% BSF meal make an ideal blend for laying hens.

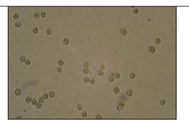




What about algae?
In addition to use of BSF for bioconversion of brewery waste into lipids and protein meal, the micro-algae *Chlorella protothecoides* has also been assessed. Yeast effluent from breweries is most often either blended with spent grains for animal feed, or processed at a water treatment plant using anaerobic digestion. Algae processing offers a low tech alternative to utilize spent yeast media as a carbon and nitrogen source for the production of lipids and protein by *C. protothecoides*. Additionally, our group using the glycerol co-product from biodiesel production for added carbon content in this process.

Methods:
C. protothecoides UTEX 256 algae used in this experiment was purchased from the Culture Collection of Algae at the University of Texas. The components of a modified basal medium are prepared as follows (per liter): 0.7 g KH_2PO_4, 0.3 g K_2HPO_4, 0.3 g $MgSO_4 \cdot 7H_2O$, 25 mg $CaCl \cdot 2H_2O$, 25 mg NaCl, 3 mg $FeSO_4 \cdot 7H_2O$, 0.01 mg Vitamin B1 and 1 ml A5 solution. *C. protothecoides* microalgae cells were suspended in the basal medium with supplement of 30 g/L pure glucose and 4 g/L yeast extract (50 wt% as total organic carbon and 15 wt% as total nitrogen) and this was used for algae growth as a control group (BM-GY). The substrate used for waste group were prepared by mixing brewer fermentation waste (Stock I with 2.48 g/L total nitrogen and 26.38 g/L total organic carbon) and crude glycerol (Stock I I with 30.55 wt% total organic carbon) to obtain the equivalent quantities of initial concentration of total organic carbon and total nitrogen as in control group.

C.protothecoides has shown a good adaptability of growing in brewer fermentation waste and biodiesel crude glycerol. Brewer fermentation waste was shown to be a potential nitrogen source and parts of carbon source too. At the same time, the results also gave convincing evidence of feeding crude glycerol as a carbon source for algae growth. In addition, the results displayed in this study showed that 81.5 wt% of total organic carbon (mean value of three batches) and 65.1 wt% of total nitrogen (mean value of three batches) within the mixed waste group were removed by algae which indicated there was a possibility of combining biofuel production and industrial waste water treatment in the future.



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