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MASTER THESIS PROJECT

Determination of chemical composition of algal and insect biomass generated during fruit and vegetable waste remediation.

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Summary:

In recent years multidisciplinary circular processes have matured to the point of commercial application as sustainable means of tackling the global challenge processing food waste. For organic waste (e.g., fruit and vegetable waste), microbial degradation under anaerobic conditions, termed anaerobic digestion, has been an effective centrepiece of these processes. Not only is the solid waste degraded, but the process produces biogas and nutrient rich liquid waste. The biogas can be used for heating, cooking, or generating electricity, while the nutrient rich liquid or anaerobic digestate (AD) has found use as valuable agricultural fertiliser. With an ever-growing market, AD processing plants are generating far more digestate than can be safely applied on farmland. Too much AD application, similar to other fertilisers, can lead to negative ecological impacts on the applied land and water streams.

Microalgae have been demonstrated to be exceptional organisms for bioremediation of nutrient rich wastes, mainly because of their capacity of growing in adverse conditions and ability to utilise harmful components in wastewater (e.g. ammonia). The use of species like *Chlorella vulgaris* for the bioremediation of AD and generation of valuable biomass has been widely reported. Given the wide diversity of ADs and culture conditions, any microalgae-centric remediation effort requires front-end process optimisation. In first instance, this means analysis of the feedstock for the microalgae production and lab-scale determination of best conditions that produce the greatest biomass, and which has the market-determined, best biochemical characteristics.

In contrast to microalgae, *Hermetia illucens* or Black soldier fly (BSF) has shown the capacity to transform many forms of solid organic waste and generate high lipid and protein biomass.

The present project funded by the Royal Society, as part of a collaboration with multiple partner universities and companies, aimed to determine whether a circular waste remediation system could be developed to connect the following processes: 1) organic waste remediation by anaerobic digestion => 2) microalgae cultivation of AD => 3) BSFL farming on feed whose composition is improved by supplementation with microalgae => 4) BSFL frass to be used to improve soil for farming fruits and vegetables.

This project set out to use analytical biochemistry to assess the impact of the circular model on the different end products obtained from the first of the above three processes (not enough time to address the final fruit and vegetable farming process). The biochemical composition of *Chlorella vulgaris* grown on AD, and BSFL supplemented by the obtained algal paste was determined. In addition, the capacity of microalgae to accumulate and as part of a feed forward loop, pass on nutritional high value products (e.g., vitamin B12) to the BSFL was assessed.

The results showed that Chlorella biomass grown on AD had an elevated polyunsaturated fatty acid (PUFA) profile; and three times more vitamin B12 than the commercially available supplement powder and twice more than the Chlorella grown in control media (no AD), while maintaining overall protein and pigment concentrations. In the case of the BSFL, data collected to date indicate that most biochemical components tested are not significantly impacted when BSFL are fed on a microalgae-enriched diet. This said, our preliminary studies also indicate that BSLF do accumulate certain algal pigments, although further research in needed to verify this finding and to change the experimental set up and feeding periodicity to enhance the bioaccumulation potential of BSFL for valuable compounds like PUFAs and liposoluble vitamins.