SNAPSHOT

UTILIZATION OF MICROALGAE TO PURIFY WASTE STREAMS AND PRODUCTION OF VALUE ADDED PRODUCTS

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Project Description

Australian red meat processing facilities produce significant volumes of wastewater during slaughtering and cleaning operations that have high concentrations of organics and nutrients. The current wastewater treatment process is mostly focused on anaerobic digestion (AD) to decrease the concentration of organics and comply with water discharge regulations. However, the treated wastewater effluents still suffer from high nitrogen and phosphorus concentrations that do not comply with current regulations for safe off-site discharge and for recycling purposes. Nutrient removal with traditional treatment processes is often characterised by high costs associated with energy and chemical inputs. The need for novel cost-effective treatment processes that aim at recovering the nutrients whilst producing a treated water effluent that is safe for recycle/discharge is perceived as a priority by the meat processing industry.

AMPC and Murdoch University have recently concluded a research project on the feasibility of the integration of a microalgae cultivation step with existing wastewater treatment processes at selected Australian abattoirs. The proposed system integrates a microalgae cultivation step on the effluent from AD and generates two products: i) a nutrient-depleted water effluent suitable for on-site recycle within abattoir's operations, and ii) a 30% solids algae biomass product suitable for aquaculture feed and on-site use as animal feed and/or fertiliser.

Project Content

The project is structured as a desktop study characterized by a thorough literature review and mathematical modelling component. Overarching objective is to investigate a new technological approach for the transformation of nutrient contents in red meat processing wastewater streams into protein rich biomass via microalgae cultivation. The literature review has demonstrated the maturity and robustness of microalgae cultivation as a cost-effective treatment technology able to capture nutrient and harvest algae biomass whilst producing a nutrient-depleted water effluent. Through the development of mass and energy balances at selected Australian abattoirs, the output of a microalgae cultivation system integrated on the AD effluents has been quantified. The potential for the effluent from microalgae cultivation to be reused and recycled within the abattoir's operations has been addressed through an environmental and risk assessment analysis in the light of current Australian food safety standards. A cost-benefit analysis has estimated capital, operational and unit production costs of the integrated microalgae cultivation system at the selected Australian abattoirs. A sensitivity analysis has discussed the uncertainty associated with the results of the modelling exercise and the need for further research to validate the proposed process.

Project Outcome

The project outcome in terms of mass and energy balance, costs and process uncertainty is represented in Figure 1 and summarised below:

1. An open pond microalgae cultivation system that receives 2 ML/d of AD effluent from the existing abattoir's wastewater treatment generates two product streams:
   (i) About 1.3 ML/d of nutrient-depleted water suitable for recycle/discharge;
   (ii) About 3 to 5 tons of microalgae biomass product at 30% solids.
2. At an average concentration of nitrogen and phosphorous in the AD effluent ranging as 150-250 mg/L and 25-35 mg/L, respectively, an 80% to 100% nutrient removal and fixation of 6 to 10 tons/d of carbon dioxide into algae biomass are foreseen;
3. Capital and operational costs are estimated at AUD 2-4M and AUD 1-2M, respectively, for an open raceway pond algae cultivation system followed by settling and centrifugation;
4. Algae unit production costs range between AUD 1.5 to 2 per kg of algae product, thus competitive with the current market price of microalgae sold as animal feed and fish meal (ranging from AUD 1.5 to 20 per kg of algae).

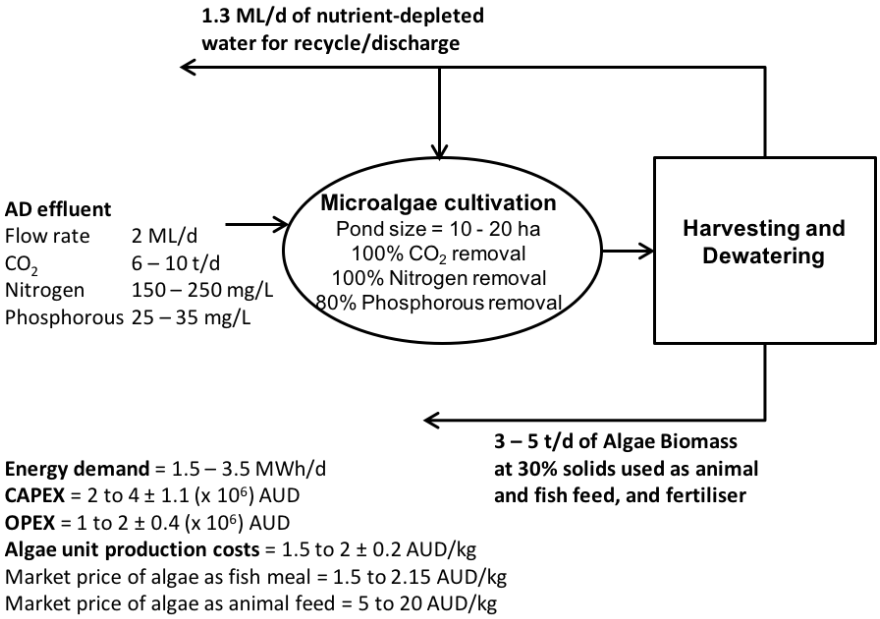

Figure 1. Summary of project outcome.

Benefits for Industry

The proposed treatment system is expected to:

1. Improve the environmental footprint of abattoirs as it:
   (i) Decreases carbon footprint by sequestering carbon dioxide and avoids ammonia volatilisation;
   (ii) Reduces environmental impacts associated with current practices and related to nitrogen and phosphorous contamination of soil, freshwater and groundwater.
2. Implement a "waste-to-profit" strategy by reclamation of the environmental and economic value of the wastewater effluent in terms of water and nutrient recovery;
3. Improve current management practices related to water usage and wastewater treatment by treating large volumes of wastewater to allow on-site reuse/recycle and off-site safe discharge;
4. Generate an algae biomass by-product that is suitable for energy generation through biogas production or as a potential revenue stream for the abattoir from the sale as animal feed or other products.