Microalgae culture to treat piggery anaerobic digestion effluent

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Abstract

The use of microalgae technology for the treatment of piggery anaerobic digestion effluent offers attractive advantages over current wastewater treatment systems used by Australian piggeries. These include recovery of nutrients in the form of biomass that might be used as pig feed or for the production of biofuel or other energy production, better recycling of water, improved economic returns and environmental outcomes.

This study utilised bioprospecting strategies which incorporated the selection and culture of algae species which were capable of growing on undiluted, untreated piggery anaerobic digestion effluent. The successful isolation of a *Chlorella* species using a synthetic medium containing 500 mg NH_3-N L^{-1} and the operation of several raceway pond cultures over 20 weeks with ammonia concentrations of up to 1,600 mg NH_3-N L^{-1} with a mixed algae culture provided data to support the hypothesis that algae culture is possible for this application.

The data showed that high pH levels, temperature extremes and variable nutrient composition could be accommodated through the careful management of an outdoor pond system. It was also found that some aspects of the algae growth performance such as chlorophyll content can be improved by the addition of CO_2 to the culture medium.

Summary of project outcome

Bioprospecting conducted in this study for isolating microalgae culture capable of growing at piggery anaerobic digestion effluent with no dilution and only sand-filtered was very successful. Bioprospecting conducted on several samples collected from different sources around Perth resulted in isolating high ammonium resistant *Chlorlla* sp, a *Scenedesmus* sp and a pennate diatom. Laboratory long term trials indicated *Chlorella* sp as the most dominant species on the untreated anaerobic digestion effluent.

The growth of these species under batch and semicontinuous modes on the outdoor paddle wheel driven raceways was also tested for 20 weeks with successful growth of algae in four ponds on filtered un-treated anaerobic digestion effluent. *Chlorella* sp was the main dominant species during this period of time in all ponds. Addition of CO_2 resulted in significant increase in biomass yield and chlorophyll content. *Chlorella* sp was shown to be able to grow between 500 and 1,600 mg NH_3-N L^{-1} (Medina anaerobic digestion effluent was between 240 and 690 mg NH_3-N L^{-1}).

The results of this study clearly indicated potential of using algae for removing nutrients from the untreated effluent from piggery waste anaerobic digesters.

Industry and future directions

So far the outcome of the project is very positive. To date anaerobic digestion effluent from piggeries cannot be used for many purposes and is mostly left to be evaporated in large lagoons. However, this effluent contains a vast amount of nutrients. The potential of culturing algae on untreated effluent has several advantages such as reducing the carbon foot print and producing usable biomass and clean water. In our knowledge, this is the first study indicating the potential of culturing algae on un-diluted anaerobic digestion effluent. Our results also indicated the potential of establishing a long term microalgae culture in outdoor ponds in Perth for treating this effluent.

This was a proof-of-concept study which illustrates the potential of culturing algae in such an effluent with high ammonium content. There will be need for more studies on: a) further bioprospecting to isolate elite species of algae for this application, b) optimising culture management and growth conditions, c) understanding the interaction of algae growth and effluent chemistry, d) determining long term nutrient uptake rates, e) determine the effect of external CO_2 on long term growth and f) determining the carbon and energy balance of the process and its economics.

The outcome of such study can be applied by not only the piggeries but also can provide solutions for industries with the similar types of waste waters.