



Editorial

The potential of using wastewater for microalgal propagation

Globally, efforts are continuing in sourcing renewable energy sources that are both economically feasible and environmentally friendly. This necessitates a complete paradigm shift in balancing the need for environmental protection concurrently with economic growth in a sustainable manner. More recently biofuels derived from biomass such as crops has elicited much debate especially with regards to concerns related to food security. To overcome the latter concerns, over the last three decades there has been much emphasis on algae-based biofuels more specifically biodiesel. However, except for a few demonstration scale plants for which ample evidence of success has not been forthcoming in the public domain, much of the developments in this field have been limited to the academic sphere. Some of the key challenges to large scale application which are underpinned by unfavorable economics include lack of suitable harvesting technology for open pond systems and non-chemical methods for oil extraction from the algal biomass. In addition, the access to fresh water required for propagation of the algal biomass has become a major impediment. By this token, in recent times, much of the research conducted by my group and others globally has focused on investigating the feasibility of using waste streams for microalgal propagation.

Fresh water is a scarce resource which is too often taken for granted. The water footprint of algal biofuels cultivation can be as large as 3726 kg of freshwater per kg algal biomass produced if cultivation is carried out without recycling. Even with a recycle in place, the numbers of cycles possible are limited due to the potential accumulation of inhibitory substances to microalgal growth. The use of seawater is a potential avenue to reduce the freshwater footprint, however; it cannot totally negate the freshwater requirement as some amount of water is required to prevent excessive changes to osmoregularity of the system by salt build up and to compensate for evaporative losses. Evaporative losses from open ponds can be as high as 10 L.m².day⁻¹ and thereby up to 410 kg water per kg biomass produced. The use of wastewater can reduce the requirement for freshwater by over 90%. This requirement may further be reduced by the utilization of treated wastewater.

The cultivation of microalgae requires copious amounts of nitrogen and phosphorus for their cultivation at commercial scale. The cost of cultivation of microalgae using conventional media accounts for up to 30% of the total cost of biodiesel production. The costs associated with the supply of chemical media are estimated to be approximately \$2500 to \$3000 ton⁻¹ of biomass produced based on the production of 100 tons per annum. Mined phosphorus is estimated to be exhausted in the next 30 years. Furthermore the greenhouse gas emissions generated as a result of commercial nitrogen and phosphorus fertilizer production may account for up to 50% the greenhouse gas emission of algal biofuels production, if commercial fertilizers are utilized as a substrate for cultivation. This gives an imminent need in sourcing an environmentally friendly and cost effective substrate towards improving the feasibility of algal biofuels production.

Wastewater generally contains large amounts of organic matter, nitrogen and phosphorus. Treatment of wastewater for nutrient removal to acceptable levels before discharge is essential for environmental protection. Conventional nutrient removal is a cost and energy intensive biological

process. The cost of conventional removal of nitrogen (N) and phosphorus (P) is reported to be \$4.4 kg⁻¹ N and \$3.05 kg⁻¹ P removed. With the new impetus towards environmental consciousness and the zero waste concept, wastewater is now being viewed as a resource rather than a problem.

Coupling wastewater treatment with biofuels production is a very attractive option for energy, freshwater and fertilizer reduction. Wastewater as a substrate for algal cultivation provides an effective nutrient base for algal cultivation. It contains much of the macronutrient requirements and trace elements required for algal cultivation with the enormous benefit of being a source of water for cultivation. Wastewater serves as a complete medium equivalent to chemical media from a kinetics standpoint. Cultivation of microalgae using wastewater has the potential to reduce the nitrogen requirement by up to 94% and totally negate the need for addition of potassium, magnesium and sulfur. Cultivation of microalgae that are able to undergo mixotrophic growth provides a significant advantage in the removal of organic carbon from wastewater in addition to nitrogen and phosphorus. This enables nutrient recovery and conversion of CO₂ into biologically bound carbon. As it is a "freely available" resource, the use of wastewater for algal cultivation has the potential to significantly improve the economics of biofuels production.

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