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Extracting value from non-portable water using halophilic algae: a water-food-energy nexus approach for delivering bioenergy

Patricia J Harvey
University of Greenwich, UK

Statement of the problem: Global energy consumption will grow by up to 50% by 2035; 60% more food will be needed and global water use for irrigation could increase by 10% by 2050. Glycerol, a new biofuel and by-product of biodiesel manufacture, is planned to be combusted using new engine technology (410kW electrical; 450kW thermal) to provide heat and power at the University of Greenwich UK, provided sufficient reliable supplies of glycerol can be sourced at the right specification. Biofuels, however, can necessitate substantial water inputs depending on feedstock production: by 2030, the global blue biofuel water footprint might have grown to 5.5% of the totally available blue water for humans, causing extra pressure on fresh water resources.

Methodology & Theoretical Orientation: The blue water footprint of the net energy provided by microalgal biofuels has been concluded to be significantly smaller compared with fuels from other energy crops. Extremophile, halotolerant microalgae such as *Dunaliella* produce glycerol without the requirement to process lipids to release the glycerol. The potential for commercial glycerol production from *Dunaliella* was examined in the D-Factory, a €10m, 14-partner, FP7-funded project (2013-2017).

Findings: *Dunaliella* can be cultivated at large-scale in hypersaline water using solar energy and with minimal fresh water and flue-gas CO_2. These algae can be processed for glycerol and a range of high-value products for disease mitigation, and biomass can be used in new food products and in feedstuffs. A demonstration is underway to show the potential for commercialization of algae such as *Dunaliella*. From this work, the scope to produce commodities such as glycerol from algae is discussed in the context of the water-food-energy nexus and circular economy.

Conclusion & Significance: Awareness of the water-food-energy nexus offers opportunities to utilize algae sustainably for the production of biobased products.

Recent Publications:

1. Anonymous (2014) The Water-Energy-Food Nexus: A new approach in support of food security and sustainable agriculture. Food and Agriculture Organization of the United Nations
2. Gerbens Leenes P W et al. (2012) Biofuel scenarios in a water perspective: the global blue and green water footprint of road transport in 2030. Glob. Environ. Change. 22(3):764-775
3. Gerbens Leenes P W et al. (2014) The blue water footprint and land use of biofuels from algae. Water Resour. Res. 50(11):8549-8563.
4. Avron M and Ben Amotz A (1980) Production of glycerol, carotenes and algae meal. US Patent no. 4199895.
5. Psycha M et al. (2014) Design analysis of integrated microalgae biorefineries. Computer Aided Chemical Engineering. 34:591-596.

Biography

Patricia J Harvey is a Senior Expert in bioenergy value chains, and the water-food-energy nexus, with particular focus on the use of algal and non-food plant systems for the capture of CO_2, use of non-potable water and production of green chemicals and biofuels. She is a Coordinator of several projects including: "the CO_2 microalgae biorefinery: D-Factory"; a 10 million Euro FP7-funded project "Macrobiocrude", (EPSRC-funded); Non-food bio-oil supply chains (EU-ACP-funded) aimed at capacity building measures in South Africa, Namibia and Ghana to create sustainable, non-food supply chains; Ecotec21 (EU-Interreg) which installed novel, biofuel-fired CHP technology at the University of Greenwich (UK) using biooils and glycerol; tuning algae for biofuel profitably (NERC, Innovate UK).

p.j.harvey@gre.ac.uk