Abdullah and Hussein *Bioresour. Bioprocess.* (2021) 8:40
https://doi.org/10.1186/s40643-021-00396-0

Bioresources and Bioprocessing

REVIEW

Open Access

Integrated algal and oil palm biorefinery as a model system for bioenergy co-generation with bioproducts and biopharmaceuticals

Mohd Azmuddin Abdullah[1*] and Hanaa Ali Hussein[2]

Abstract

Background: There has been a greater call for greener and eco-friendly processes and bioproducts to meet the 2030's core agenda on 17 global sustainable development goals. The challenge lies in incorporating systems thinking with a comprehensive worldview as a guiding principle to develop the economy, whilst taking cognisance of the need to safeguard the environment, and to embrace the socio-cultural diversity dimension as an equal component. Any discussion on climate change, destruction of eco-system and habitat for wildlife, poverty and starvation, and the spread of infectious diseases, must be addressed together with the emphasis on the development of cleaner energy, air and water, better management of resources and biodiversity, improved agro-practices for food production and distribution, and affordable health care, as the outcomes and key performance indicators to be evaluated. Strict regulation, monitoring and enforcement to minimize emission, pollution and wastage must also be put in place.

Conclusion: This review article focuses on the research and development efforts to achieve sustainable bioenergy production, environmental remediation, and transformation of agro-materials into value-added bioproducts through the integrated algal and oil palm biorefinery. Recent development in microalgal research with nanotechnology as anti-cancer and antimicrobial agents and for biopharmaceutical applications are discussed. The life-cycle analysis in the context of palm oil mill processes is evaluated. The way forward from this integrated biorefinery concept is to strive for inclusive development strategies, and to address the immediate and pressing problems facing the Planet and the People, whilst still reaping the Profit.

Keywords: Integrated biorefinery, Algae, Palm oil milling, Bioresource utilization, Bioenergy co-generation, Bioproducts

Introduction

Global carbon dioxide (CO_2) emissions from the fossil fuels have increased 15 times between 1900 and 2008 (Boden et al. 2010). This has prompted greater efforts to develop green technology and eco-friendly materials, to reduce over-dependence on fossil-based fuels and products, and green-house gas (GHG) emissions. Biorefineries aim to achieve efficient and sustainable utilization of biomass resources for the generation of bioenergy and bioproducts (Budzianowski 2017). The biomass conversion processes and equipments are integrated to produce energy, fuels, power and heat, and marketable organic feed, food, chemicals and materials (IEA 2014; NREL 2015). The biorefineries may replace the power plants, or linked to the existing biofuel plants for new biofuels generation, or by re-equipping the existing biofuels with the new bioenergy facilities, or by setting up entirely new facilities, incorporating the processing of the bioresources (Budzianowski 2017; Laosiripojana et al. 2018). The basic principle is to reduce the total raw materials and the consumption of energy per production unit,

*Correspondence: joule1602@gmail.com; joule1602@yahoo.com
[1] Institute of Marine Biotechnology, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia
Full list of author information is available at the end of the article

Springer Open

© The Author(s) 2021. This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.