



Sustainable high-quality seaweed production from deep seawater

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Abstract

The increase in the demand for seaweed biomass and high-quality products has created an urgent need for a more productive and sustainable cultivation system. Deep seawater (DSW) is rich in inorganic nutrients, unpolluted, and has low-temperature stability. Small-scale industries utilising DSW have been established, with DSW being employed for bottled drinking water, aquaculture, agriculture, cosmetics, medicine, food, and power generation—all contributing to substantial economic benefits. DSW has also been used for seaweed farming, where its high nutrient levels have increased biomass yield and biochemical composition while reducing fertiliser expenditures. Ocean thermal energy conversion (OTEC) is an emerging technology for renewable energy production. The DSW drawn up to generate energy through the temperature difference between the cold DSW and the warm surface seawater can be used for diverse applications, including seaweed cultivation. In warm tropical regions, the cold DSW can be used to manipulate the temperature of seawater to extend the range of temperate high-value seaweeds into the tropics. Malaysia has been identified as suitable for OTEC development, especially in Sabah. An ongoing OTEC research project between Malaysia and Japan includes research on value creation from the OTEC DSW through the cultivation of abalone and seaweeds. It is timely for a comprehensive review of the advantages of using DSW for seaweed farming and how the integration of this innovative technology with the OTEC system can provide value-added products and revenue to both industries, which are important components of the emerging blue economy.

Keywords Sustainable seaweed cultivation · Deep seawater · Ocean thermal energy conversion (OTEC) · Seaweed biotechnology · Blue economy

Introduction

The global aquaculture industry has experienced significant growth in recent years. World production of farmed seaweed has more than tripled since the year 2000 to reach 35,086,088.48 tonnes of fresh weight (FW), contributing to 96.86% of the global seaweed production in 2021 (FAO 2023). The remaining 3.14% of the global seaweed production,

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