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Perspective

Innovation of Microalgal Biotech for Food and Aquaculture in Coastal Areas

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DESCRIPTION

If "biotech's green gold" is to be explored in a logical and financially sustainable manner, region-specific Research and Development (R&D) of microalga-derived product systems is essential. Due to their consistent annual temperatures, abundant sunshine, and ready access to seawater, coastal regions, especially those near the equator, are frequently regarded as the best places for agriculture. However, a "cradle-to-grave" evaluation of the advancement of micro algal biotechnology in these disciplines, both in terms of laboratory and field settings, has not yet been proven. In this work, we demonstrated the development of micro algal biotechnology in coastal zones for aquaculture and food in order to assess the potential of micro algal-derived multi-product technology.

A Chlorella strain MEM25 with vigorous development in a wide range of salinities, temperatures, and light intensities was discovered through the creation and screening of a (sub) tropical microalgal collection. The stability and robustness of MEM25 across different production system designs and various spatial and temporal scales were demonstrated through evaluation of the economic viability and performance of different scale cultivation system designs at coastal zones under geographically specific conditions. Under different circumstances, it generates large amounts of proteins and Poly Unsaturated Fatty Acids (PUFAs). The nutritional benefits of MEM25 as food additives, where PUFAs and vital amino acids are enhanced and the algal diet increases consumers' growth, are revealed through feeding experiments. Economic analysis shows that producing MEM25 as food for humans or animals using ORP systems are significantly profitable. Therefore, despite the benefits and cons, there are good potential for the development of different market-ready product systems using region-specific micro algal biotechnology R&D strategies.

The wide variety of phenotypic and genotypic plasticity displayed by microalgae has been shaped by long-term adaptation to varied environments. The extraordinary variety of microalgae found in nature offers a variety of sources from which specific strains with the characteristics required for the production of commercial feedstock can be chosen for specialized use. Marine microalgae may grow on non-arable land and use saline water sources, making its usage in industrial systems appealing. It offers a viable solution to address the pressing freshwater shortage, deteriorating cropland, and growing human population that are all contributing to the world's food insecurity. Additionally, algal food made from natural strains eliminates worries about synthetic cells releasing genetically modified components.

Despite not always producing the highest yields of micro algal biomass, places around the equator are frequently regarded as ideal growing sites due to their stability in annual temperature. Particularly, the coastal region of Hainan Island is better suited for algae production than other parts of China because of factors including abundant non-arable land, high average temperatures, and abundant sunlight. The island's climate ranges from subtropical to tropical from the north to the south.

It provides advantages for strain collecting and hence constitutes a typical habitat for micro algal outdoor cultivation. Furthermore, using coastal areas for algae farming reduces environmental impact and doesn't compete with the use of arable land or biodiverse ecosystems. However, due to prolonged exposure to strong light during the summer, effective cultivation is hampered by high levels of irradiation and high temperatures. The lower winter temperatures, however, impede the growth of the microalgae and diminish the overall biomass output, despite the fact that winter temperatures in tropical regions are quite high and the winter season is relatively brief. It is vital to screen and choose marine micro algal strains that can endure a variety of environmental conditions or have traits unique to a particular place. However, a "cradle-to-grave" evaluation of the development of micro algal biotechnology in coastal regions of the (sub) tropical areas, from region-specific strain selection to development of end product at a commercial scale, has not yet been proven.

Due to its high cost and relatively low value, the economic sustainability of producing just biodiesel from microalgae is being called into doubt. Micro algal biotechnology research is reaching a turning point. In order to fully harness the potential

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of algal composition, scenarios with increased economic benefits are linked to positive environmental effects on climate change and the development of microalga-based multi-product systems, such as those providing food additives for people or animals. This study aims to conduct a "cradle-to-grave" assessment, from the selection of region-specific strains to sustainable end product development, in order to increase the commercial viability of naturally existing micro algal strains. The future of micro algal biotechnology is uncertain and at a crossroads. To boost R&D spending and policy implementation in this field, we hope that the techno-economic evaluation with the aid of "biotech's green gold" will be used in a more logical and economically viable way.