論文の要旨
（Thesis Summary）

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論文題目(Thesis Title)

Polyunsaturated fatty acid and carotenoid production from *Laminaria japonica:* Developing technologies for a cascading biorefinery process of brown seaweeds
(海洋性未利用バイオマスを利用した高付加価値油脂生産技術の開発)

New ways of obtaining energy and materials are growing fields in this age where society is facing the need to sustain an ever-growing global population while combating climate change. Some have turned to renewable biomass like that from industrial processing wastes or plants to replace petroleum as starting material.

This study is part of group of work that will make use of the brown seaweed *Laminaria japonica* for power generation (as methane), high-value chemical production (as lipids and carotenoids), and waste stream valorization in a proposed cascading bio-refinery process. It aims to contribute to the body of knowledge that will allow renewable biomass to be used for energy, food, and material production.

Chapter 2 of this study demonstrates the production of nutraceutical ingredients or feed additives such as polyunsaturated fatty acids (PUFA) and carotenoids from *L. japonica.* It emphasizes the use of a variety of microorganisms as biochemical converters in two-step processes. The first stage uses them to simplify/digest brown seaweed carbon material like mannitol and alginate to intermediates like sugars or organic acids. The second stage uses microorganisms called the thraustochytrids to ferment these intermediates to PUFA and carotenoids.

Chapter 3 presents metabolomics as a useful analysis tool to determine factors that affect the biosynthesis of the highly-antioxidant astaxanthin in thraustochytrids. Upon oxidative stress induction, astaxanthin titers surpassed that of recorded levels in other strains of thraustochytrids. Their astaxanthin productivities are demonstrated to be now at par with that of their commercial phototrophic counterparts.

The strategies presented here are expected to give economic feasibility and profitability to the complete utilization of brown seaweeds for energy and material production in integrated biorefineries. This study and related works to it focusing of pre-treatment, methane generation, and material recovery, contributes to the body of knowledge that will be the foundations for future bio-based industries, economies, and societies.