Brown and green algae enzyme-assisted extraction and lactic acid bacteria fermentation processes for increasing phenolic compounds and antioxidant properties

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Abstract

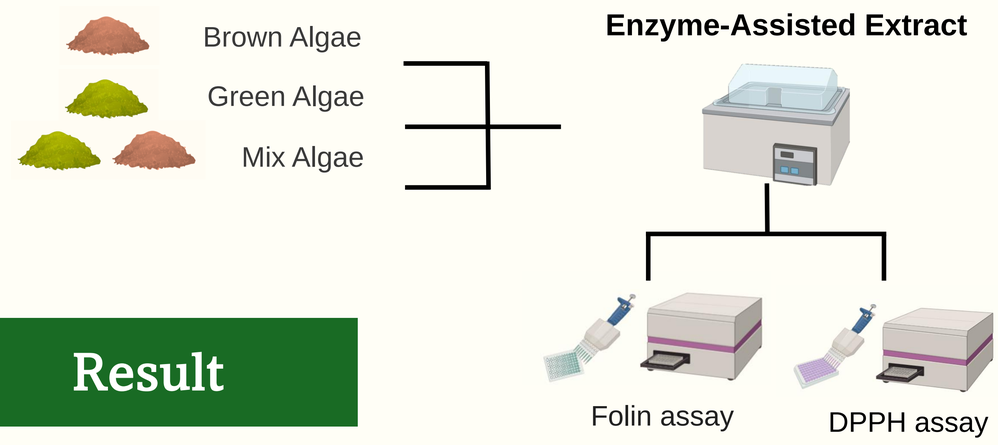
This study aimed to optimize the extraction of key compounds from brown and green algae using enzyme-assisted extraction and fermentation with lactic acid bacteria. The algae used in the experiment included brown algae, green algae, and a mixture of both (brown and green algae). The results showed that enzyme-assisted extraction increased the yield of algae extracts by 2 to 5 times compared to extraction without enzymes. Additionally, the total phenolic content in the extracts increased by 20 to 30 times. A mixture of brown and green algae at a 3:1 ratio produced the highest total phenolic content and antioxidant activity, with total phenolic content of 7.40±0.06 mg GAE/g extract and DPPH antioxidant activity of 49.36±0.48% at a final sample concentration of 12.5 mg/mL. Fermentation of the algae mixture with three strains of lactic acid bacteria further increased the total phenolic content by 40% and antioxidant activity by 20-25% during the first 3 to 5 days of fermentation compared to non-fermented extracts. These findings can be applied to the development of high-efficiency algae extracts for use in cosmetic formulations.

Introduction

The cosmetics industry has been experiencing rapid expansion. Products formulated with natural ingredients are increasingly favored among health-conscious and environmentally aware consumers. Marine algae represent a valuable natural resource with significant bioactive potential, particularly brown and green algae, which serve as rich reservoirs of phenolic compounds. These bioactive constituents exhibit crucial biological properties, including antioxidant activity, anti-inflammatory effects, and skin health-promoting benefits. Consequently, they are widely incorporated as key ingredients in cosmetic and health-related formulations. Therefore, this study aims to investigate the extraction process of mixed brown and green seaweeds utilizing enzyme-assisted extraction and lactic acid bacterial fermentation to enhance the yield of phenolic compounds and improve antioxidant properties.

Methodology

I. Enzymes Hydrolysis Of Algae



Result

Algae	Condition	% Yield	Total Phenolic Content (mg GAE/ g extract)
Brown Algae	DI Water	5.00	0.29 ± 0.06^{d}
	Enzyme A	25.20	5.82 ± 0.22^{b}
Green Algae	DI Water	31.00	0.27 ± 0.08^{e}
	Enzyme A	87.00	2.79 ± 0.07^{c}
Mix Algae	DI Water	26.00	0.33 ± 0.04^{d}
	Enzyme A	61.00	6.80 ± 0.01^{a}

Table1 Show %yield, Total phenolic content of Algae Extract

Ratio	%Yield	Total Phenolic Content (mg GAE/ g extract)	% Inhibit (%)
1 : 0	25.2 %	5.92±0.03^{e}	41.28±0.45^{b}
0 : 1	87 %	2.79±0.05^{f}	19.08±0.24^{e}
1 : 3	74 %	6.21±0.23^{cd}	25.31±0.6^{d}
1 : 2	71 %	6.15±0.15^{de}	30.06±0.60^{c}
1 : 1	64 %	6.39±0.01^{c}	29.97±3.17^{cd}
2 : 1	52 %	6.79±0.01^{b}	26.93±1.37^{cd}
3 :1	65 %	7.40±0.06^{a}	49.36±0.48^{a}

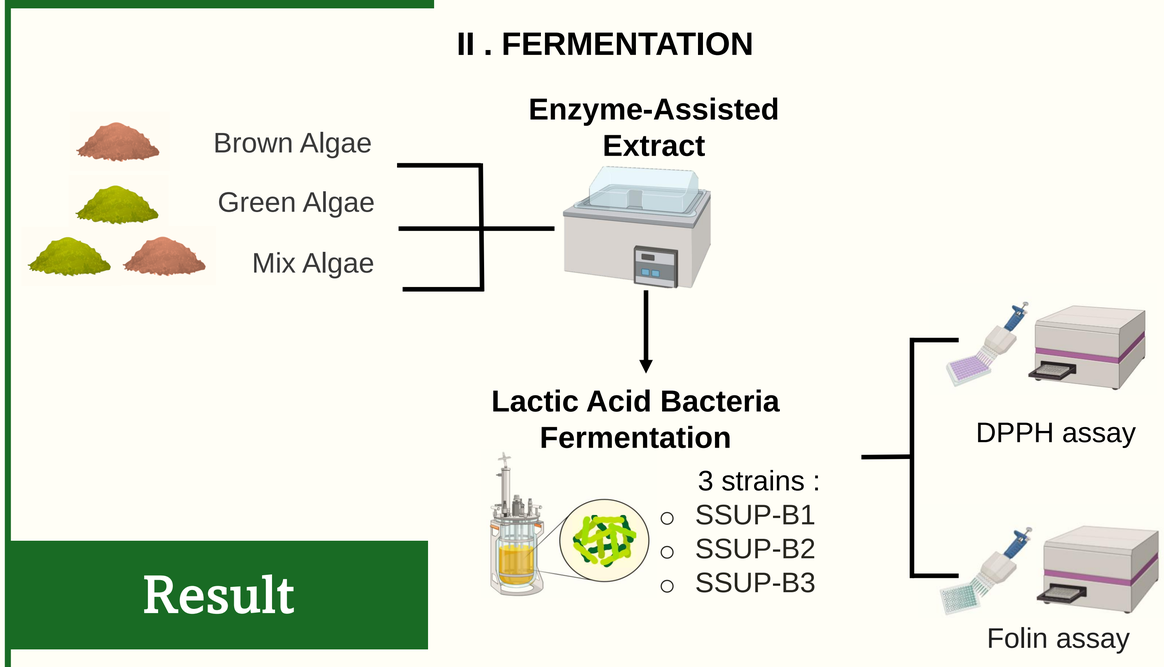
Table 2 Show %yield, Total phenolic content and Antioxidant activity of Mixed algae Extract

Reference

[1] Wang, H. D., Chen, C., Huynh, P., & Chang, J. (2014). Exploring the potential of using algae in cosmetics. *Bioresource Technology*, *184*, 355–362.
[2] Freile-Pelegrín, Y., Robledo, D. (2014). Bioactive phenolic compounds from algae. In Bioactive Compounds from Marine Foods,113–129.

Methodology

II . FERMENTATION



Result

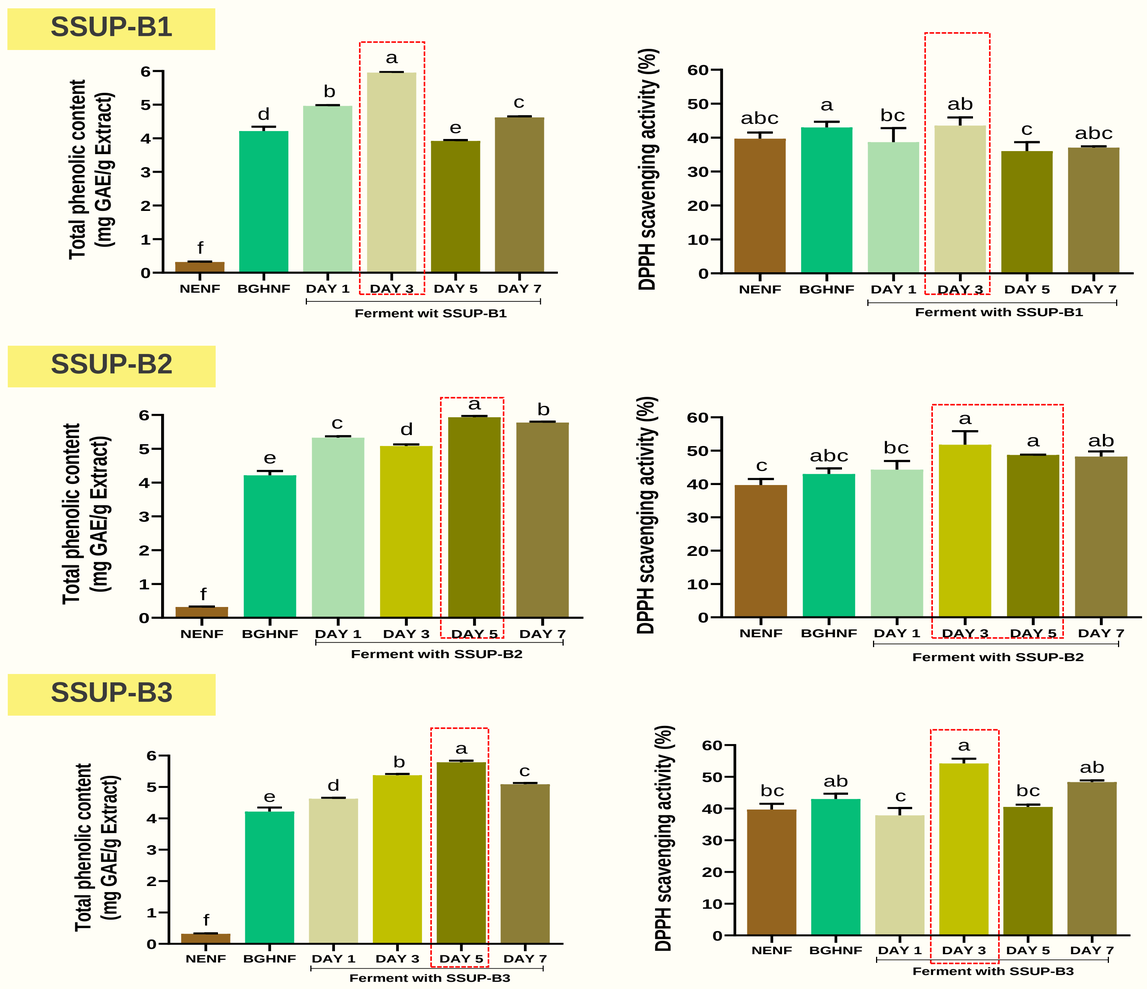


Fig. 1 Total phenolic content and Antioxidant activity of Mixed algae Extract and Fermented with Three Different Lactic Acid Bacteria

Conclusions

1. Hydrolysis of algae using enzymes increases the phenolic compounds and antioxidant activity

2. Different strains of lactic acid bacteria do not significantly affect phenolic content and antioxidant activity, with the highest levels of total phenolics and antioxidant activity observed on the third day of fermentation.