Components from Seaweed and Environmental Evaluation of Extraction Techniques

MNEXT MATERIALS & ENERGY X TRANSITION

Introduction

Synthetic dyes are a major source of industrial water pollution, particularly due to their extensive use in the fast fashion and textile industries. During manufacturing and dyeing processes, large volumes of untreated dye effluents are often discharged into aquatic ecosystems, where they can reduce light penetration, alter pH, and release toxic by-products. Many of these dyes are derived from petroleum-based compounds and are known for their chemical stability, low biodegradability, and potential to bioaccumulate, posing long-term threats to both environmental and human health. This impact is visualised in Figure 1, which shows the consequences of synthetic dye pollution in water bodies. Thus, the search for safer, biobased alternatives has become increasingly urgent.

Figure 1. Soil and Water Pollution (1)

Aim of the Project

To analyse the dye components of seaweed and to explore and compare different extraction techniques with a focus on their environmental sustainability and potential for biobased dye applications, aiming to contribute to the development of environmentally friendly, bio-based dye source.

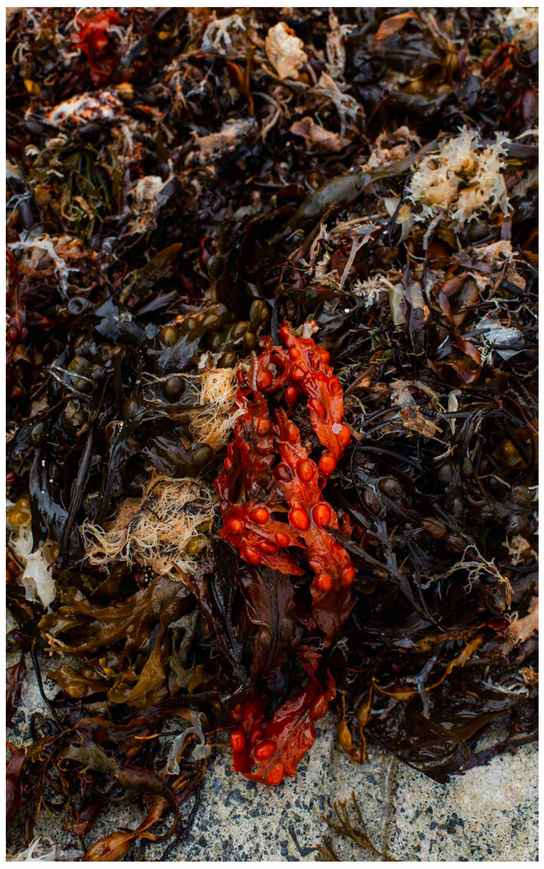

Figure 2. Different Types of Seaweed (2)

Figure 3. Dyed Yarn from Zeefier (3)

Methods

Dye components were extracted from seaweed using two approaches: a conventional solvent-based method and a supercritical CO_2 extraction with a co-solvent. The resulting extracts were analysed using High Performance Liquid Chromatograph (HPLC) to compare dye composition and extraction efficiency.

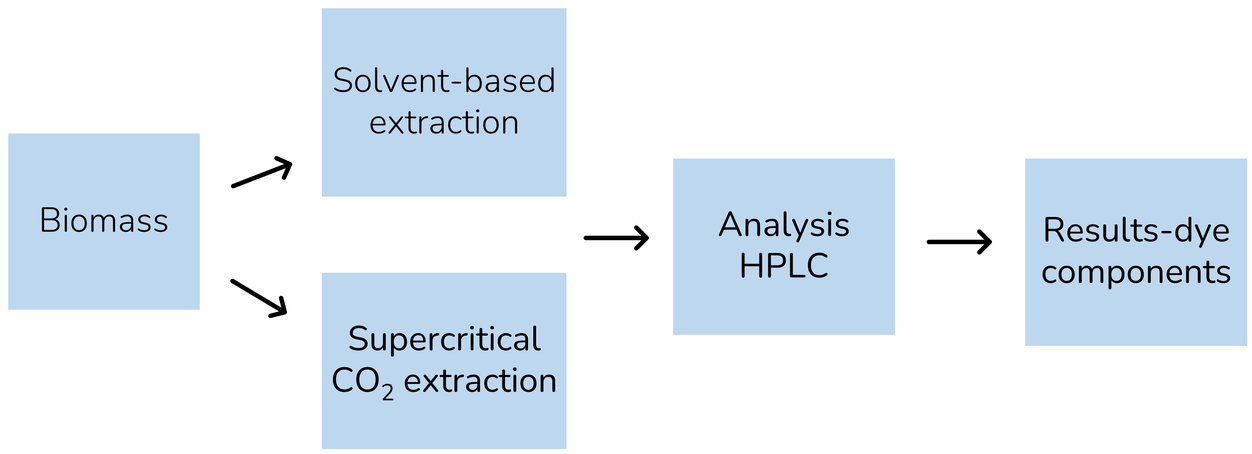

Figure 4. Methods Diagram

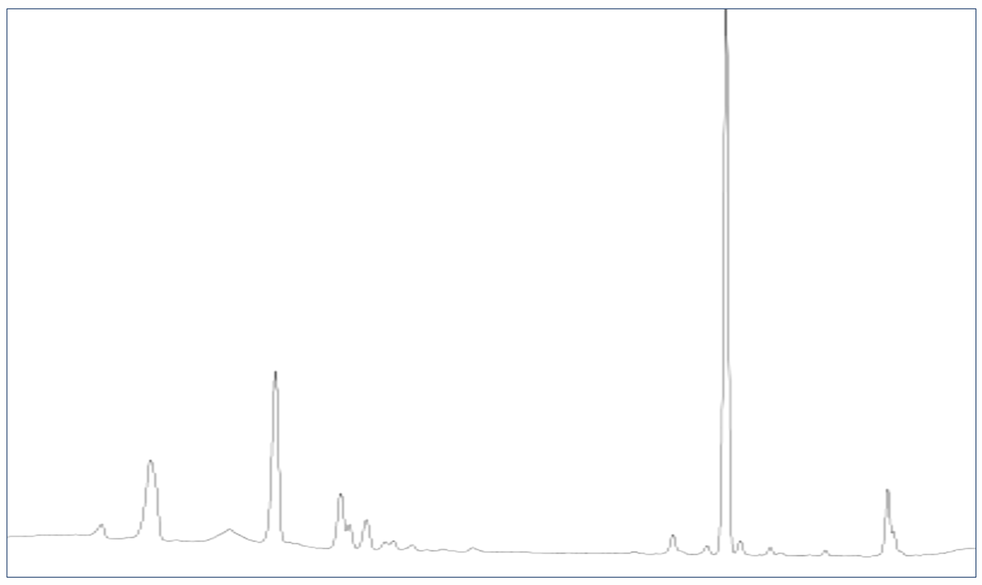

Figure 5. HPLC Chromatogram of components

Environmental Assessment

To assess the environmental impact of the two extraction methods, four criteria were evaluated and compared:

The total electricity used during the extraction process, including heating, compression, and equipment operation.

The amount of CO_2-equivalent emissions generated based on energy use, calculated using national emission factors.

Assessed based on the volume and type of solvents involved, focusing on toxicity, volatility, biodegradability and bioaccumulation.

Evaluation of the number and quality of dye components recovered, including signs of degradation or loss.

Reference

1. To Dye For: Textile Processing's Global Impact. Danielle LaRose, April 2017, Business Insider/Stringer/Reuters.
2. Bree Anne – Unsplash (2023). Mixed seaweed on rocky surface.
3. Zeefier (2025). https://zeefier.eu

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Date: 12 June 2025