SDU Syddansk Universitet

Techno-Economic Feasibility of Arabian Gulf Native Seaweed Bio-Refinery

Background

UAE has diverse aquatic biomass which lives in a very harsh environment of hot climate and high-water salinity. While seaweed has been studied around the world for its rich biochemical components and for energy feedstock, UAE native seaweed is yet to be explored for its potential biorefinery capacity.

Seaweed is well known for its nutrition's value, high value chemicals such as bioactive components for pharmaceutical applications, renewable energy feedstock and its potential environmentally friendly and sustainable nature. Seaweed has been used as source of food mainly in Eastern Asia Countries for a while, it was also considered as potential energy feedstock for production of renewable liquid and gas fuel [1]. However due to immaturity of renewable energy technology, the renewable energy in general has faced some difficulties in competing fossil fuel in the energy market. Due to this facts, more recent interest in seaweed bio-refinery focused primarily on high value chemicals extraction such as wide range of bio-compounds with pharmaceutical, biomedical, and nutraceutical importance [2]. Bioactive molecules extracted from marine seaweed has been shown effective results against diabetes and other health concerns which drag a scientific and commercial interest in seaweed bioactive molecules [3]. Anti-inflammatory, antioxidant, anti-cancer, anti-diabetic and much more of bioactive molecule that have pharmaceutical applications from seaweed biomass [4, 5].

Aim

- Study the chemical and biochemical properties of Arabian Gulf native seaweed.
- Develop a novel biorefinery process based on Arabian Gulf Seaweed *Ulva sp* for production of bioactive molecules and biofuel (jet fuel).
- Study the economic feasibility of co-production of high value chemicals (bioactive molecules) and biofuel (jet fuel)

Objective

- Biomass fractionation optimization
- Identification of bioactive molecules
- Bioactivity of the extractives
- Biofuel (Jet fuel) production routes evaluation
- Develop novel bio-refinery process for production of bioactive molecules and biofuel(jet fuel)
- Techno-economic feasibility study

Facts and Figures

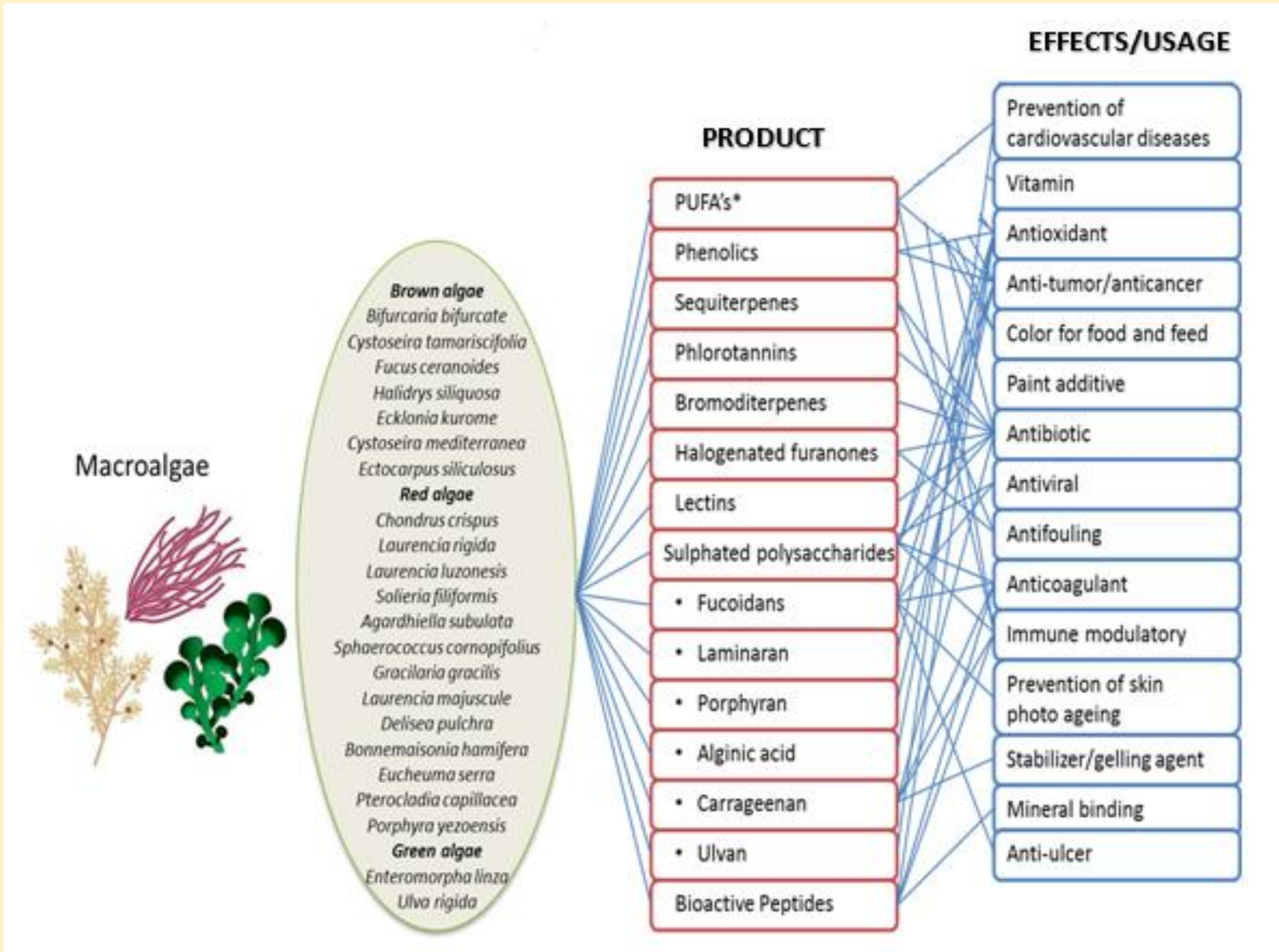

Figure 1 : Components of secondary metabolites of marine algae and their possible application [6]

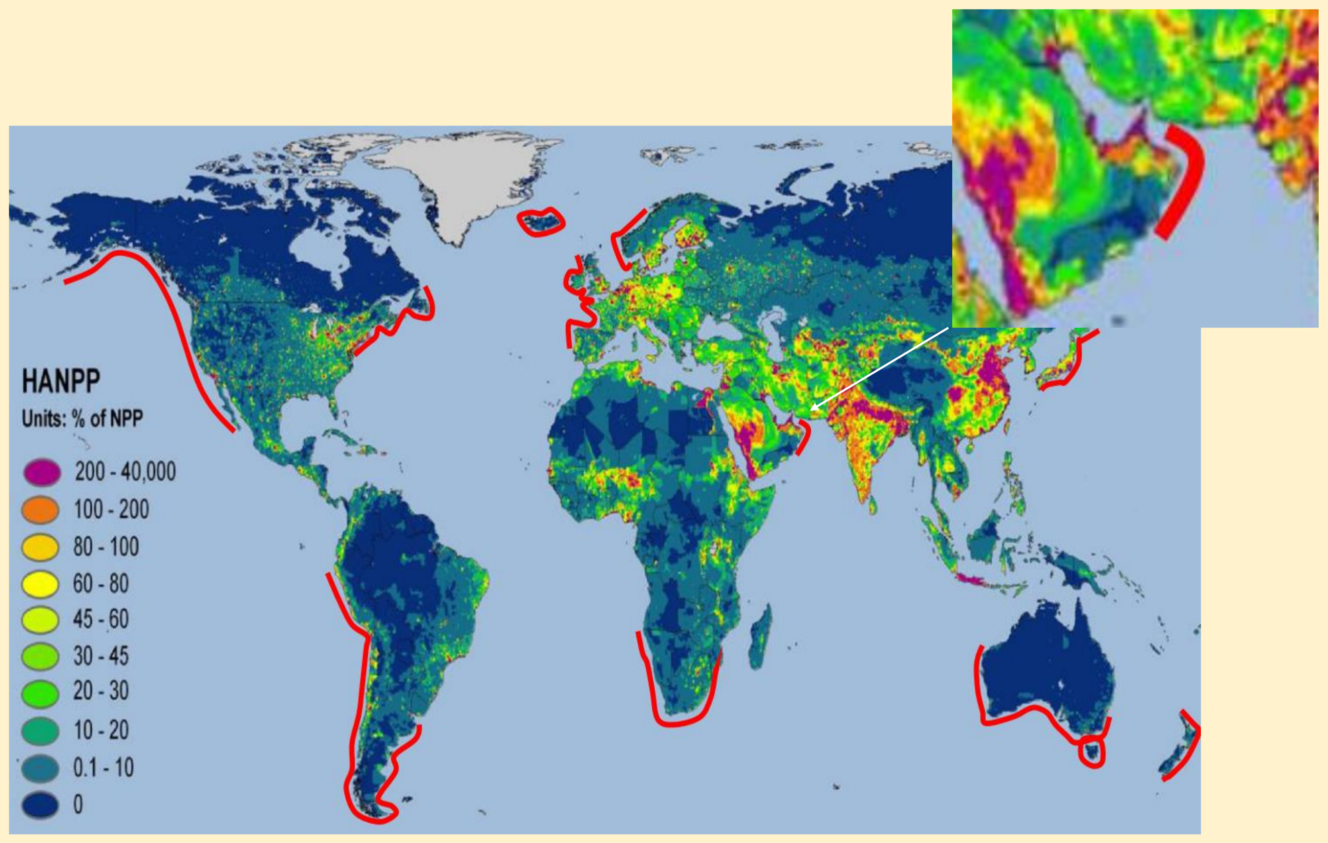

Figure 2 : Global natural distribution of shallow water Seaweed, with focuses on UAE as the Arabian Gulf bay host shallow water Seaweed with high net primary productivity (NPP) [7].

Methodology

Activity	Details
Task 1 : Screening and Characterization	
1.1 Seaweed Sampling	Sampling data , time , date , area , water temperature , TDS , pH and seaweed bloom area
1.2 Chemical Characterization of Seaweed Biomass	TS , TDM (Total Dry Matter) , Ash contents
Task 2 : Develop fractionation and separation processes to obtain Bioactive Molecules , protein, and sugars from Seaweed	
2.1 Extraction and Separation techniques	liquid-liquid extraction, infusion, percolation, digestion and hot continuous extraction (Soxhlet). Supercritical CO2 extraction is another method used to extract compounds with pharmaceutical significance. Extraction fractionation might be combined with membrane separation if this is needed in order to achieve clean fractions of high value components
Task 3: Chemical characterization of the different fractions	
3.1 Chemical characterization of extracts	Chemical composition of extracts and identification of interesting compounds and groups of compounds will be analyzed using GC-MS (qualitatively) at and LC-MS/MS (quantitatively).
3.2 Chemical characterization of biomass fiber fraction (carbohydrates, , ash and extractives)	Chemical characterization of lignocellulosic components will be performed using acid hydrolysis of the dried and milled biomass followed by standard HPLC methods followed by Klason lignin determination.
Task 4 : Assessing Bioactivity of Native Seaweed Ulva Sp	
4.1 Antioxidant content of the seaweed	Different methods (DPPH radical scavenging method)
4.2 Antimicrobial activity of the seaweed	Different methods (test on gram positive and gram negative bacteria)
4.3 Anti-diabetic activity of the seaweed	Different methods (In vitro study)
Task 5 : Seaweed Residue Biofuel (Jet Fuel) Process Evaluation	
5.1 Evaluation of biochemical Routes	Based on seaweed's residue process
5.2 Evaluation of Thermochemical Routes	Based on seaweed's residue process
Task 6 : Process design and modeling (TEA)	
6.1 Process Design	Based on experimental data (SuperPro Simulations)
6.2 Scenario analysis	SuperPro Simulations
6.3 Sensitivity Analysis	SuperPro Simulations

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