SCREENING FOR OILS IN IRISH AND TURKISH SEAWEED: YIELD AND QUALITY

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Abstract

The MABFUEL project (FP7-IAPP) investigated the feasibility of using marine algae as feedstock for bio-fuels in Turkey and Ireland, exploring several possible pathways. The yield and quality of seaweed oils was assessed for the most abundant species of the intertidal of Ireland (SW coast) and up to 1.5m depth in Turkey (Mediterranean, Aegean and Black Sea), in different times of the year. Pre-treatments included washing and oven or freeze drying. Oil extraction methodologies consisted in: 1) Soxhlet extraction (n-hexane) 2) Rapid transesterification for analysis of Fatty Acid Methyl Esters (FAME) 3) Saponification in methanol and 4) Methylation analysis. The resulting FAME were extracted (n-hexane) and analysed using a Gas Chromatograph (GC) coupled with Flame Ionization Detector (FID). Seventeen seaweed species were analysed from Ireland: 2 Chlorophyta, 11 Ochrophyta and 4 Rhodophyta and the total yield of oils ranged from 0.3% (dry wt. basis) in *Colpomenia peregrina* to 5.9% (dry wt. basis) in *Bifurcaria bifurcata.* From Turkey, a total of fiftteen species were screened: 2 Chlorophyta, 8 Ochrophyta and 5 Rhodophyta with yields ranging from 0.3% (dry wt. basis) in *Gracilaria gracilis* to 8.0% (dry wt. basis) in *Dictyota spiralis*. Neither the time of collection nor the drying method applied seemed to influence the oil extraction yields. Quality wise, the extracted seaweed oils had high amounts of polyunsaturated fatty acids (PUFAs) or saturated fatty acids (SFAs), which contribute, respectively to reduced oxidative stability and cause unsuitable viscosities and poor cold flow properties for fuels. Based on our results we consider that the seaweeds analysed are not suitable for biodiesel. However, those species may provide a good source of high valued compounds, especially for nutraceutical applications. For that purpose, a sustainable biomass source must be assured and, thus future research efforts should be placed in developing aquaculture methodologies for the species of interest.

MABFUEL

Introduction

World wide energy consumption is expected to increase steadily. To meet this demand sustainable, clean-energy sources must be produced and used more extensively than ever before. One of those sources is bio-energy, which is produced when chemical energy stored in biomass is utilized. While **bio-diesel** is produced mainly from vegetable oils and animal fats, commercial **bio-ethanol** is produced from starch and sugar containing biomass. The main issue associated with the **first generation bio-fuels** is the global increase in food prices, since the most used feedstocks for production of first generation bio-fuels are also food crops [1]. Therefore, there is a growing attention for **algae-based biofuels** since they do not compete with food and feed resources and have high growth rates. This project assessed the feasibility of some common **marine algae as a feedstock for biofuel production**.

Methods

- Identification and collection of the most abundant seaweed species from different sites in SW Ireland and Turkey (Mediterranean, Aegean and Black Seas)
- Freeze-drying or oven-drying of samples
- Grinding prior to Soxhlet extraction with n-hexane
- A rapid transesterification method was employed for the fatty acid methyl esther analysis. Extracted oil samples were first saponified with an excess of NaOH in methanol and then methylated in the presence of BF_3 (10% - 14%) in methanol. The resulting fatty acid methyl esthers (FAME) Were extracted with n-hexane and kept in sealed GC sample vials for further analysis.

FAME analysis was performed using an Agilent 6890A Gas Chromatograph coupled with Flame Ionization Detector (FID).

Experimental Results

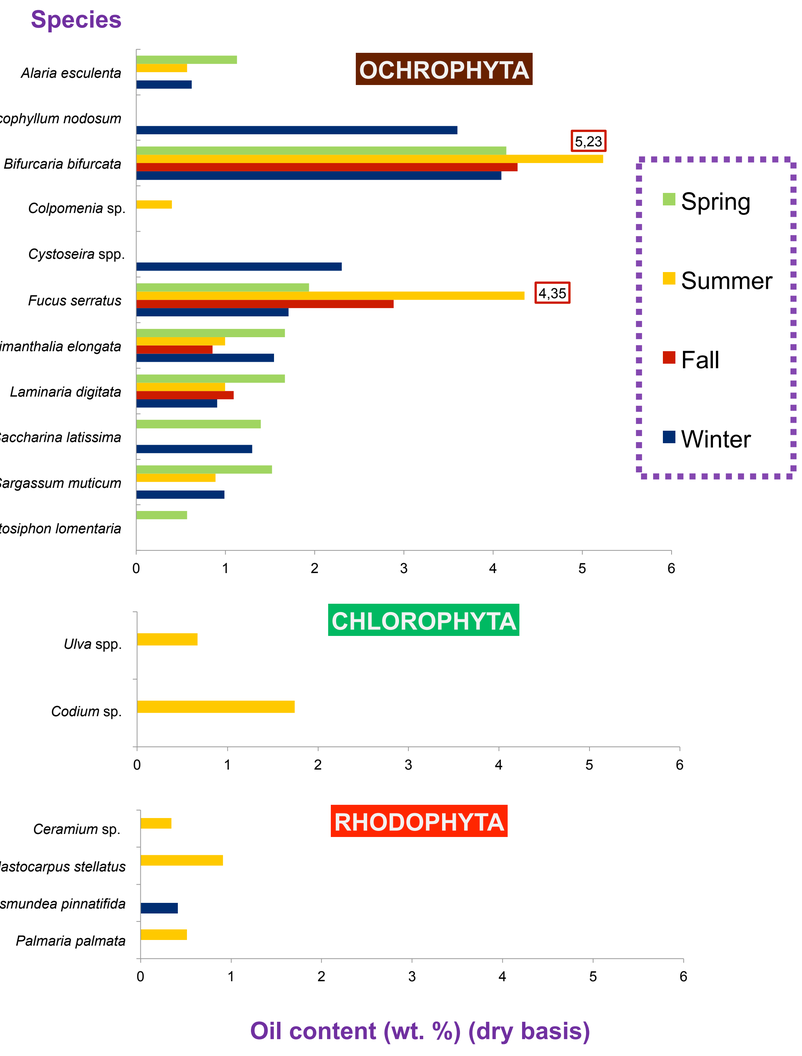

Figure 1. Oil contents (dry basis) of seaweeds collected from Ireland.

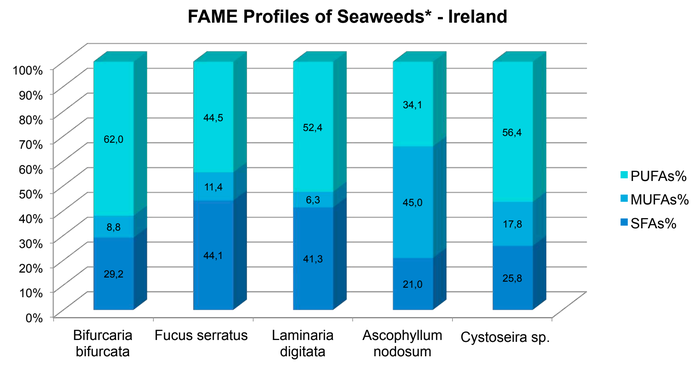

Figure 3a. FAME Profiles of seaweeds collected from Ireland
* Top 5 seaweeds in terms of high-oil content are shown.

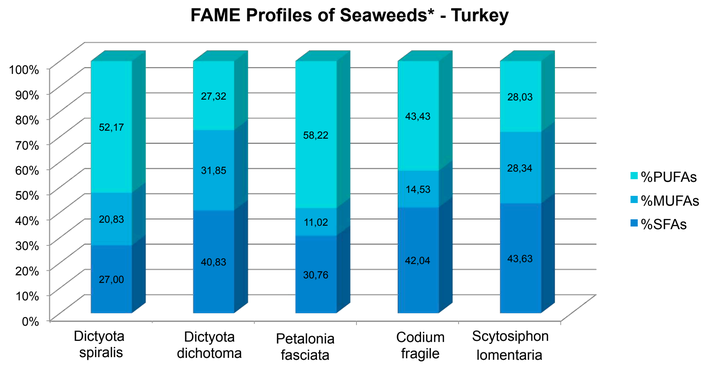

Figure 3b. FAME Profiles of seaweeds collected from Turkey
* Top 5 seaweeds in terms of high-oil content are shown.

Brown seaweed were the most abundant species in the sampled sites (SW Ireland and Turkey) and also showed the highest oil content (up to 8%). However, when compared with crops such as rapeseed and soybean, seaweed have very low oil yields. Among the species screened, *Bifurcaria bifurcata* and *Dictyota spiralis* had the highest oil-content. Neither the time of collection nor the drying method applied seemed to influence the oil extraction yields significantly (data not shown). In terms of quality, extracted oils have high amounts of either polyunsaturated fatty acids (PUFAs) or saturated fatty acids (SFAs) which are not desirable for fuels. PUFAs contribute to poor oxidative stability and SFAs can cause unsuitable viscosities and poor cold flow properties [2].

Conclusion

Bio-diesel production from seaweed does not seem to be viable since none of the studied species have more than 10% of oil and, qualitywise, most of them are rich in PUFA's which is not desirable for bio-diesel production. However, these FAME compositions will lead future work on these seaweed species potential as **nutraceutical supplements**.

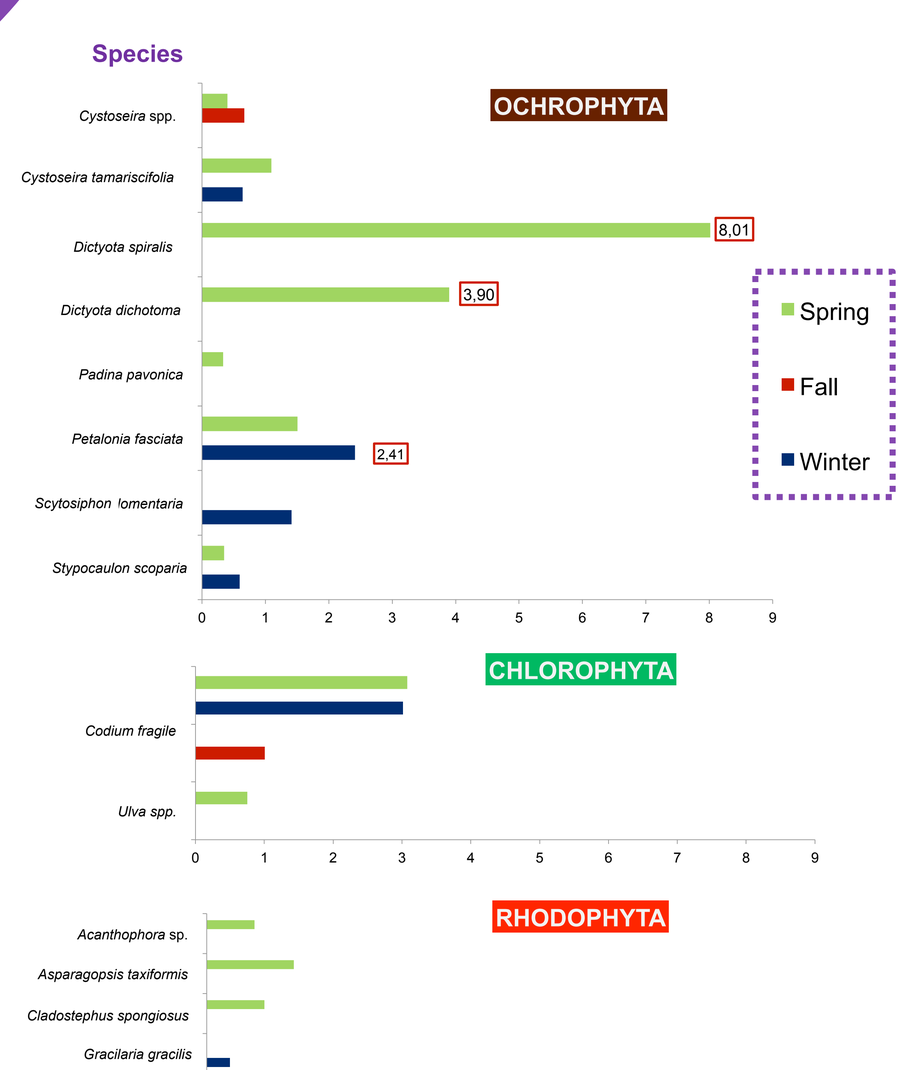

Figure 2. Oil contents (dry basis) of seaweeds collected from Turkey.

REFERENCES:
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[2] GR Stansell et al**. Journal of Applied Phycology**, Volume 24, Issue 4, August 2012