Chemical and Enzyme-Assisted Extraction of Fucoidan from two Species of Brown Macroalgae (*Ascophyllum nodosum* and *Saccharina latissima*)

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Introduction

Macroalgae are vital species and are known to produce a wide range of bioactive compounds including polysaccharides, such as fucoidan. Traditionally, these compounds are extracted using hazardous solvents that leads to environmental pollution and waste. Considering this, more sustainable technologies are being investigated as greener alternatives.

The main goal of this study was to compare the fucoidan yield of a conventional extraction (CE) with a new, greener extraction method (enzyme-assisted extraction, EAE) from two species commonly found in Norway: *Ascophyllum nodosum* and *Saccharina latissima*. In addition, other sugars-, alginate- and polyphenol-content was measured. One cellulase (Cellulase 13) and two multifunctional enzymes (Depol 692 and Depol 793) was tested in EAE.

Results and Discussion

The chemical composition and amount of the extracts obtained varied with the extraction method used for both species. The CE method resulted in a much higher fucose and carbohydrate yield from *A. nodosum*, indicating higher release of fucoidan and other polysaccharides (incl. alginate) compared to the EAE method (Figure 2). In fact, the fucose content (measured by IEX chromatography and RI detection) was approximately 100 times higher after CE compared to EAE (using the selected enzymes) and the control.

Also, for *S. latissima*, the CE method resulted in the highest extraction yield of fucose (Figure 3). Although EAE provided a slightly higher extraction yield of glucose and xylose compared to CE, none of the enzymes used in this study showed a high extraction efficiency compared to the control or CE. None of the methods were efficient in extraction polyphenols/phlorotannins.

Materials and methods

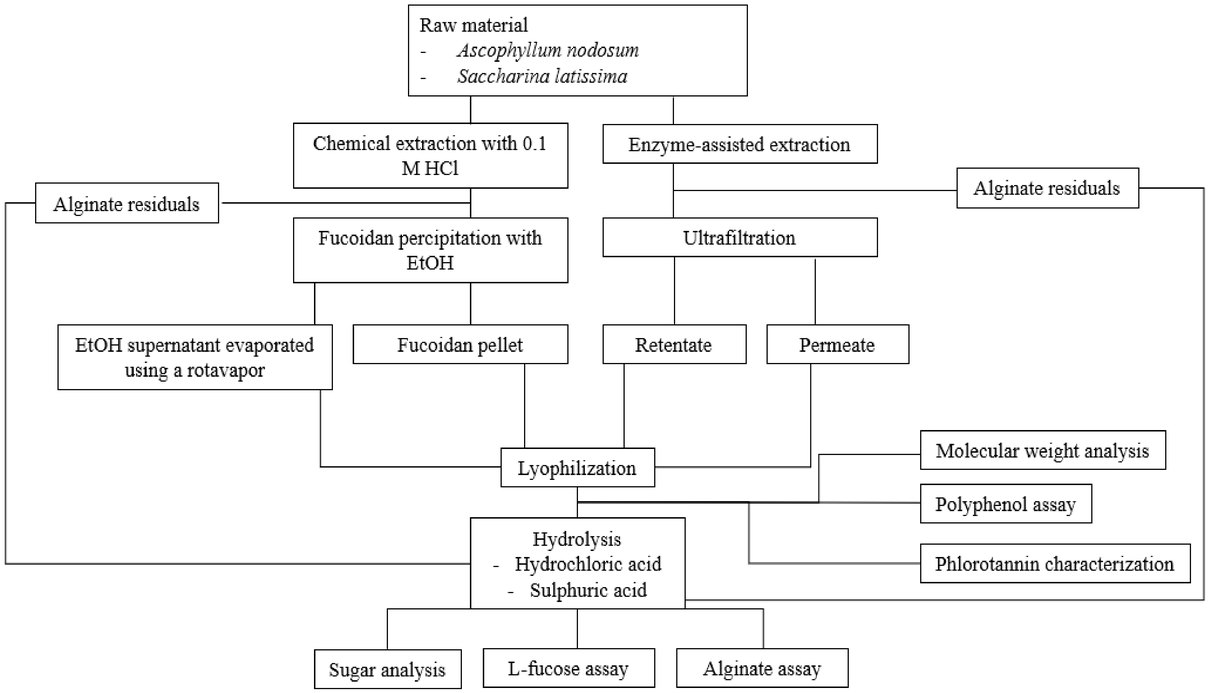

Figure 1. Flowchart of the Chemical (CE) and Enzyme-assisted extraction (EAE) method. After extraction, alginate residuals was removed by alginate precipitation with 2% $CaCl_2$. CE was conducted at 80 C for 4 hours at 60 rpm. After CE fucoidan was precipitated from the extract using 72% ethanol. The ethanol was then evaporated from the supernatant using a rotavapor. EAE was conducted using three different enzymes and a control sample. The extraction was performed at 50 C for 3 hours at 60 rpm, at pH 5. After EAE the extracts were filtrated using ultrafiltration to separate components based on their molecular weight, using a membrane with a molecular cut off of 100 kDa. The different fractions was then lyophilized. Lyophilized material was used to determine the molecular weight distribution of polysaccharides and the polyphenol/phlorotannin content in the samples. Two hydrolysis methods were performed on the lyophilized material, one with hydrochloric acid and one with sulphuric acid. After hydrolysis, the sugar-, fucose- and alginate content was analysed.

Conclusion

The main goal of the project was to compare the efficiency and yield of a new greener method of extraction (EAE) against a selected conventional method (CE), where the main compound for comparison was fucoidan**.** Although the two different extraction methods produced different results in the two species analysed, **the CE method resulted in the overall highest extraction yield of fucoidan in both species.** This was most evident in extracts from *A. nodosum*. None of the enzymes used in the EAE method proved to be efficient in extracting fucoidan. However, the enzymes showed a potential in degrading the algal cell wall.

Further work

More studies are needed before EAE can be used industrially. Furthermore, **the extraction of valuable compound from algal species can be explored using more specific enzymes or adding a processing step**. This can be followed up in my PhD project, where i will investigate the extraction of proteins/peptides from red algae.

Read the whole thesis here!

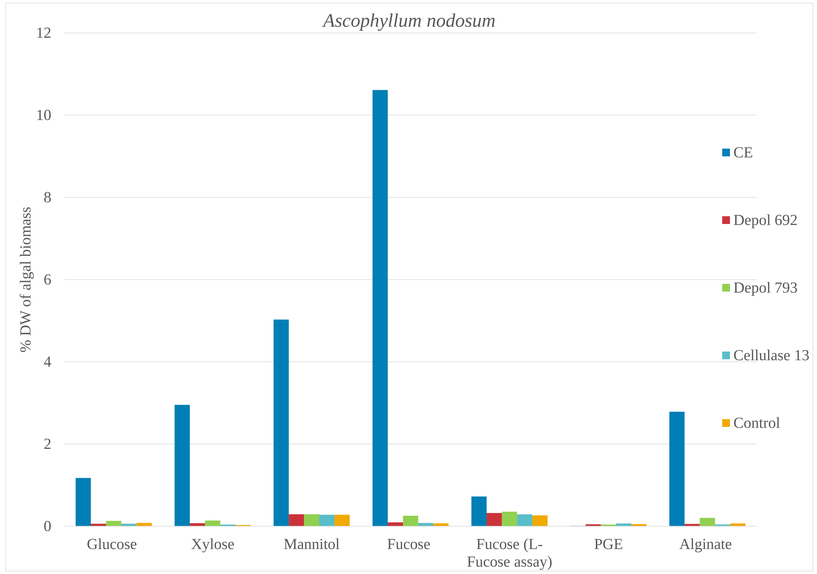

Figure 2. The total yield of the analysed valuable components from *A. nodosum* after CE and EAE (all three fractions combined). The data is presented as total percent dry weight (DW) of the total algal biomass. The hydrolysis method with the highest yield was used to calculate the % DW of the total algal biomass.

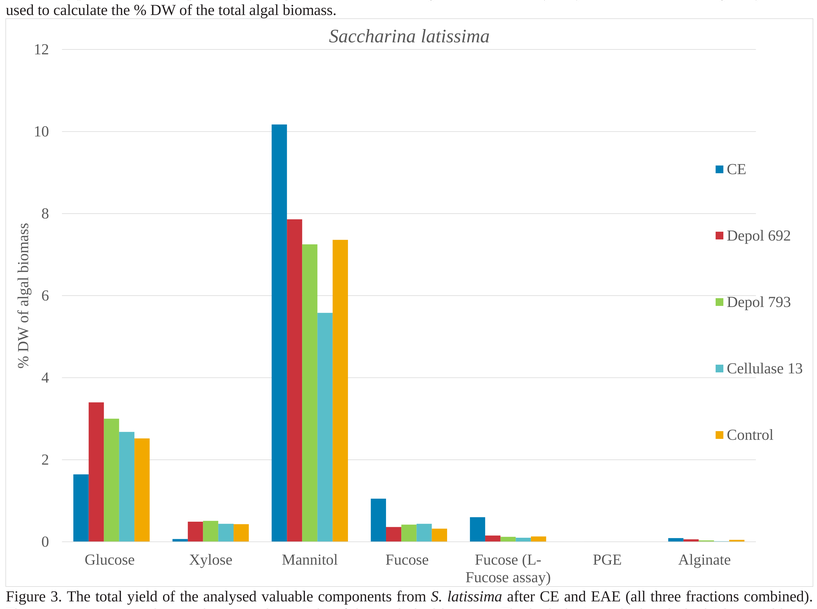

Figure 3. The total yield of the analysed valuable components from *S. latissima* after CE and EAE (all three fractions combined). The content is presented as total percent dry weight of the total algal biomass. The hydrolysis method with the highest yield was used to calculate the % DW of the total algal biomass.

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