Locality : Biorefined Algae towards novel products in EU – The biostimulant application

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Introduction

The Locality project is designed to create algae value chains to reduce waste streams from producing industries. Its purpose is to develop Innovative and sustainable solutions in 3 regional ecosystems in the North and the Baltic Sea. Applications of those solutions are specifically targeting the food, aquafeed, biostimulant, biocontrol and textile markets.

Plants are exposed to an ever-increasing number of environmental changes that cause them to undergo more and more stresses (e.g. hydric, saline, nutritive). Algae-based products are a promising solution for increasing resistance to the various stresses that plants have to cop with. In fact, studies showed that compounds present in seaweed have an effect on biotic and abiotic stress resistance [1], improvement of root architecture, enhancement of biochemical and metabolic pathways and enhancement plant growth and productivity[2]. Brown seaweeds are known to contain active compounds (e.g. mannitol, fucoïdans, phenolic compounds) whose type, quantities, structure can vary according to species, location, seasonality. So, seaweed extracts composition can be very different depending on the species of seaweeds used, their origin and the extraction process. Indeed, extraction conditions have a major influence on the composition of the extract.

The aim of this study was to produce extracts from several brown seaweeds with different biochemical composition in order to evaluate their potential for biostimulant activity on few crops and under nutritionals and drought stress.

Material and methods

Three different types of extraction were carried out on six biomasses supplied by project partners (Origin By Ocean and Nordic Seafarm) and by ALGAIA : acidic, neutral and alkaline conditions (figure 1). After the extraction step, a concentration step was performed to ensure that all extracts had a similar dry matter content. Three biomasses from brown seaweeds : *Saccharina latissima* from tops and stipes, *Ascophyllum nodosum* and three by-product from *Ascophyllum nodosum*, *fucus vesiculosus* and *Sargassum sp.* were used for the extractions.

All biomasses used, liquid extracts and by-products obtained were analyzed to obtain the biochemical composition in carbohydrates (neutral sugars and uronic acids), inorganic matter and phenolic compounds (only for the liquid extracts). Inorganic matter was obtained by calcination, carbohydrates were identified and quantified by HPAEC-PAD and phenolic compounds were quantified using a colorimetric reaction based on the method described by Sanoner *et al*. (1999)[3]. The results are expressed as a percentage of dry matter.

The extracts produced were tested to assess their biostimulant activity on lettuces seedling subjected to drought stress, at three concentrations 1, 3 and 5L/Ha. The response of this activity on the dry weight variation relative to the negative control under different irrigation levels (100%, 50%, and 25%) is presented on boxplot form.

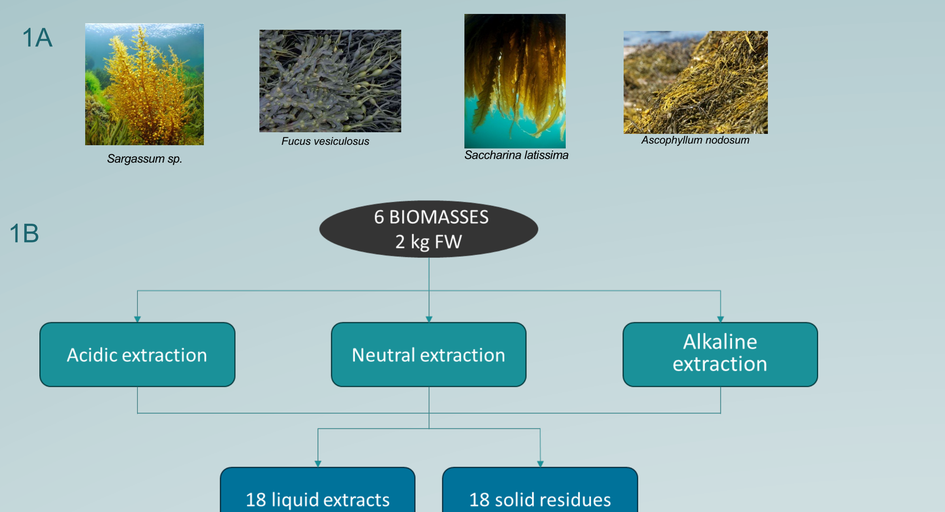

Figure 1 : Diagram showing the seaweed species used (1A) and the different extraction processes (1B).

Results

Eighteen extractions were performed with extraction yields varying according to species and nature of extractions (figure2). Extractions on by-products showed the lowest extraction yields especially for *F. vesiculosus* by-product (<10%) while the highest were obtained with *S. latissima* tops.

The extracts show a relatively similar composition between the different processes for one biomass, but the biochemical profiles differ between the different biomasses. Extracts from *F. vesiculosus* have a different composition due to the absence of mannitol. Composition of extracts from *S. latissima* stipes show the lowest laminaran content and the highest inorganic matter content.

The response on lettuce seedlings to seaweed extracts applied at varying concentrations is different according to the drought intensity (figure4). At 100% irrigation, the vast majority of the extracts performed better than the negative control except sargassum by-product extract at acidic condition extraction (figure 4A). At 50% irrigation, many extracts show better result than the negative control but SLT-Ac (1 and 3 L/Ha), SLS-N (3 L/Ha), SLS-Ak (5 L/Ha), ANBP-Ac (3 L/Ha), SBP-N (5 L/Ha) and FBP-Ak (3L/Ha) present the greatest effect. At 25% irrigation, few extracts have clearly a positive effect : SLT-N (5 L/Ha), SLS-Ac (1 L/Ha), ANBP-Ac (3 L/Ha), AN-N (1 and 5 L/Ha), FBP-N (3 L/Ha).

Biomasses	Nature of extraction	Extraction Yield
Saccharina latissima tops	N	43,62%
	Ac	49,56%
	Ak	56,79%
Saccharina latissima stipes	N	34,64%
	Ac	39,93%
	Ak	37,16%
Ascophyllum nodosum by product	N	12,86%
	Ac	16,50%
	Ak	37,53%
Ascophyllum nodosum	N	25,35%
	Ac	31,07%
	Ak	36,04%
Sargassum By product	N	14,92%
	Ac	26,93%
	Ak	24,23%
Fucus by product	N	4,24%
	Ac	7,57%
	Ak	8,18%

Figure 2 : Extraction yields (in percentage).

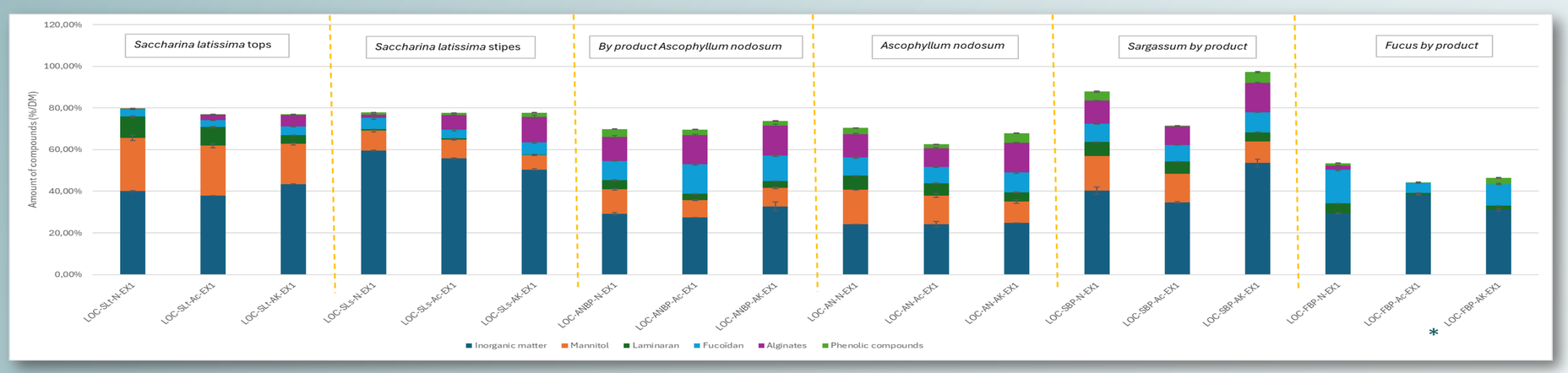

Figure 3 : Graphical representation of inorganic matter, mannitol, fucoidan, laminaran, alginate and phenolic compounds content of the extracts obtained (expressed as a percentage of dry matter). (*: alginate content is not available due to an artifact during analysis)

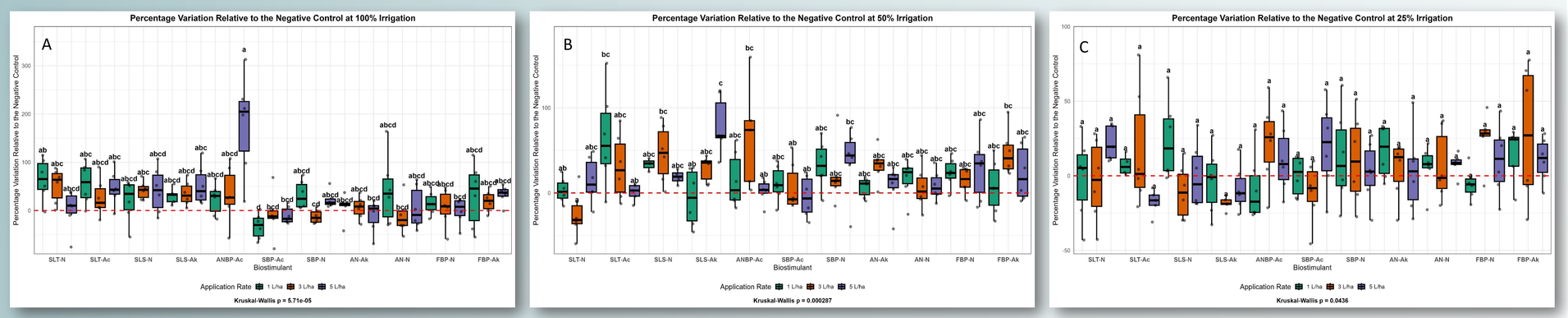

Figure 4: Boxplots showing the response of lettuce seedlings to algae extract biostimulant application on the dry weight variation relative to the negative control under varying irrigation levels (100%, 50%, and 25% respectively A, B and C). Algae extract were SLT-N; SLT-Ac; SLS-N; SLS-Ak; ANBP-Ac; SBP-Ac; SBP-N; AN-Ak; AN-N; FBP-N; FBP-Ak, each tested at three concentrations 1, 3 and 5 L/ha. For each boxplot, different letters are statistically different at P <0.05 (Kruskal Wallis test (4<n<6).

Conclusion and future work

This work has identified clear Biostimulant effects through draught resistance of lettuce seedlings after applications of specific seaweed extracts. The key is to relate these effects with the extract composition and applied doses in order to improve identification of active compounds and thus better positioning in the future.

After a selection of few extracts, field trials will be planned on several crops in order to confirm the preliminary results obtained.

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