Levels of bioactive compounds in *Ulva* spp. grown in different integrated systems.

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Introduction

Ulva properties associated to its biochemical composition are characterized by several compounds useful in fields like medicine, nutraceuticals, animal feed, and bio-material construction. Their cultivation efficiency and bioremediation ability makes them valuable macroalgae for integrated multitrophic aquaculture (IMTA). The present work studied the effect of two different water sources with different nutrient concentration using the same production system and of two different production systems using the same water source on growth, proximal composition, and antioxidant and anti-inflammatory properties of *Ulva* biomass.

Material and methods

Ulva biomass samples were analysed in five periods representative of Winter and early Spring conditions. *Ulva* was cultured in floating cages and raceways (Fig. 1). The water sources to study the effect of nutrient concentration were a water pond reservoir that feed an aquaculture and the settling pond for the fishponds (Fig. 2). The analysed parameters are in Table 1 and the effect of nutrient concentration and production system were analysed by principle component analysis

Fig. 1 – Diagram representative of the experimental units A – floating cages; B – raceway tank.

Fig. 2 – A – reservoir pond; B – settling pond;

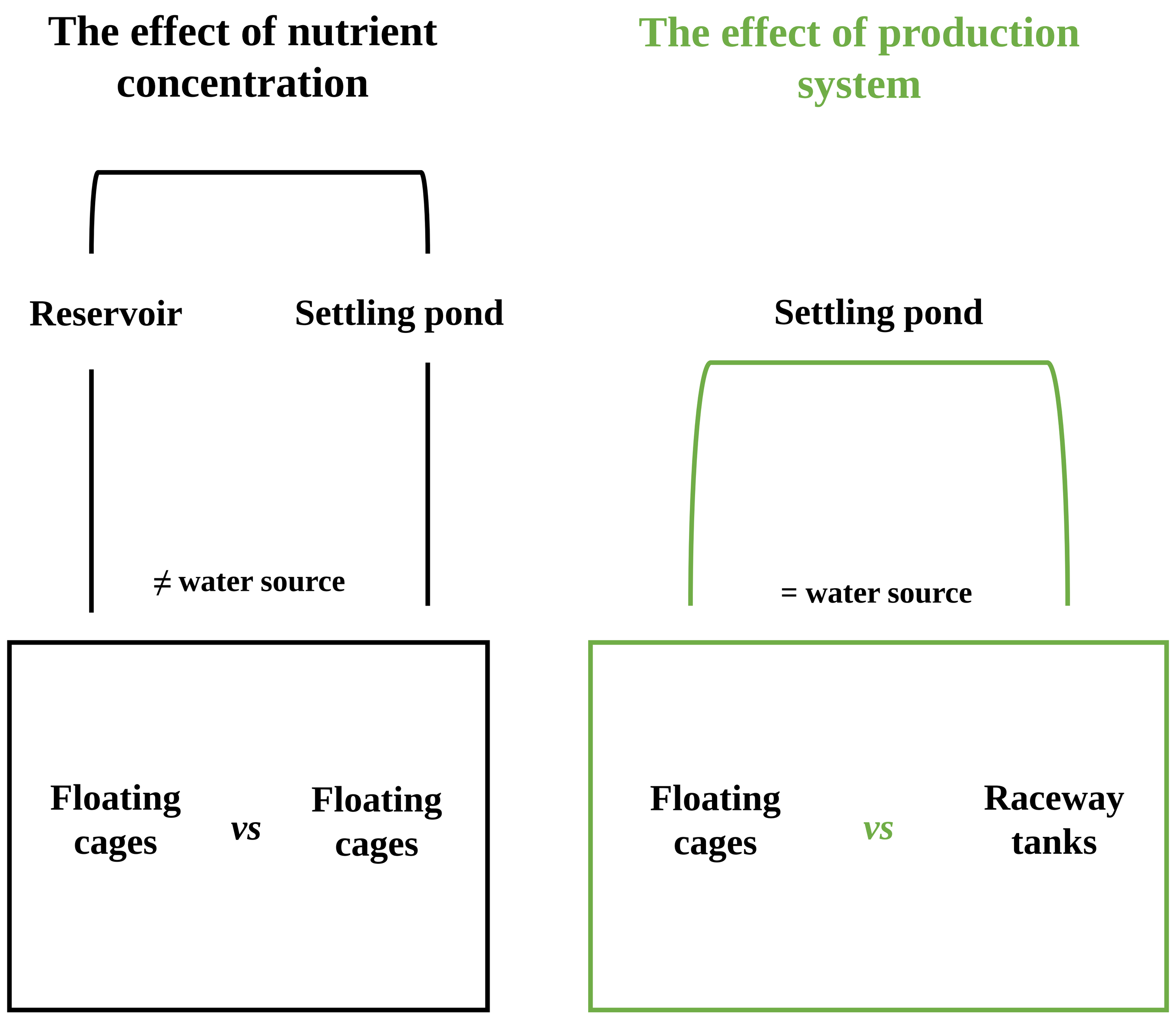

Table 1 – Parameters, sample type, frequency and sampling location

Parameter	Sample type	Frequency	Sampling location
Nutrient determination	Water	Weekly	
Growth estimation; Moisture; Dry weight; Ash; Organic mater; Total protein; Total lipids	Biomass	Weekly	Raceways & Floating cages
Bioactive assays	Biomass	Weekly	

Results

Settling pond and floating cages biomass presented greater polyphenol and protein content, and higher growth, antioxidant and anti-inflammatory activity than the reservoir and raceways, respectively.

Why?

- Low water flow suggest nutrient limitation within the raceways
- High nutrient uptake led to higher production of protein, polyphenol and other antioxidant and anti-inflammatory compounds.

PCA demonstrated a clear separation between floating cages and raceways, nutrient sources and production periods (winter ≠ late winter and early spring).

Why?

- The lack of nutrient uptake in raceways produced lower protein and polyphenol content, and antioxidant activities compared to the floating cages.
- Most anti-activities and polyphenol content were higher during Winter, and lower during Spring;
- However, some antioxidant activities were found to increase over season, due to the rise of antioxidant metabolism in response to temperature and radiation
- Positive correlation between growth, radiation, and ammonia with DPPH, FRAP, ABTS and polyphenol content may justify the floating cages and raceways high and low antioxidant activities during spring, respectively.

High correlation between ant-inflammatory activity and organic matter.

Why?

- Reflects the high protein observed during winter, which may be due to comprise anti-inflammatory peptides.

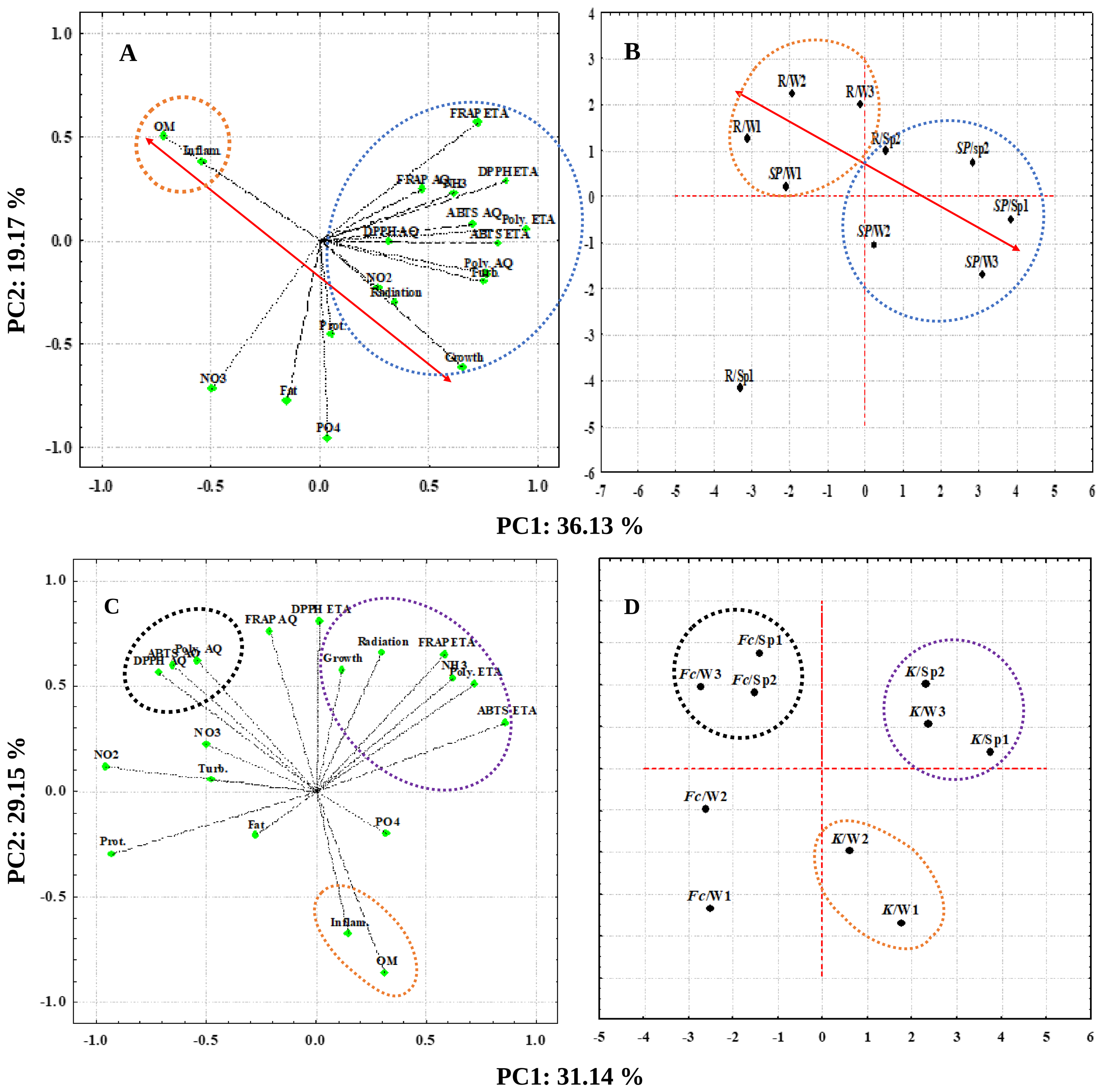

Figure 3 - PCA correlation biplot for the effect of nutrient levels (settling pond *vs* reservoir) and production system (raceways *vs* floating cages): **A) and C)** PCA correlation biplot of explanatory variables: organic matter (***OM***), growth (***Growth***), total lipid content (***Fat***), total protein (***Prot.***), radiation (***Rad.***), turbidity (***Turb.***), phosphate (***PO4***), ammonia (***NH3***), nitrite (***NO2***), nitrate (***NO3***), polyphenol content aqueous and ethanolic extracts (***Poly. AQ*** or ***ETA***), DPPH aqueous and ethanolic extracts (***DPPH AQ*** or ***ETA***) activity, FRAP aqueous and ethanolic extract activity (***FRAP AQ*** or ***ETA***) and ABTS aqueous and ethanolic extract activity (***ABTS AQ*** or ***ETA***); **B) and D)** PCA correlation biplot of water source and production systems data. Legend: settling pond (***SP***), reservoir (***R***), floating cages (***Fc***) and raceways (***K***), ***W1*** (winter, 23/01), ***W2*** (winter, 30/01), ***W3*** (late winter 06/02), ***Sp1*** (spring, 27/03), and ***Sp2*** (spring 3/04).

Conclusions

- The different nutrient concentration and different production systems influenced significantly the growth, composition and bioactive compounds of *Ulva* spp.
- In *Ks*, the high ammonia levels reflected the low nutrient uptake caused by the low water flow and inefficient aeration. *K* conditions restrained the nutrient availability, compromising protein and polyphenol yields.
- *Fc* and *SP* provided enough hydrodynamic action for efficient algal nutrient uptake, which resulted in a biomass with higher protein and polyphenol content.
- Protein, antioxidant and anti-inflammatory activities were significantly lower where the nutrient availability and uptake were limited.

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