

THE INTERACTION OF ENVIRONMENTAL NUTRIENT LOAD AND FISH WASTE CONCENTRATIONS (*DICENTRARCHUS LABRAX* L.) ON THE BIOMITIGATING POTENTIAL OF SEA LETTUCE (*ULVA LACTUCA* L.).

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Introduction

Increasing demands for food and energy, combined with a shortage of terrestrial space, stimulates the interest in expanding offshore production. Also for the North Sea, opportunities for offshore production are being investigated. Stakeholder conflicts and space limitations led to the exploration of developing Multi Use Platforms (MUPs), where various activities are combined at a shared offshore location. An often mentioned example of activities that can be combined in MUPs, is offshore wind farms together with aquaculture production. To create sustainable production sites, it is important that responsible aquaculture practices are being implemented (Stuiver et al., 2012).

Integrated Multi-Trophic Aquaculture (IMTA) systems are often proposed as sustainable aquaculture practices for the future (e.g. Troell et al., 2009 and Chopin et al., 2012). The general concept of IMTA is straightforward: species of different trophic levels are linked in such a way that wastes resulting from one species (i.e. fed species) become resources for species at lower trophic levels (i.e. extractive species). This approach aims to create aquaculture systems which are economically stable, social accepted and ecological sustainable (Chopin et al., 2012).

Although the general concepts and principles of the IMTA approach have been explained broadly (e.g. Chopin et al., 2012 and Toell et al., 2003), difficulties exist in quantifying the efficiency of IMTA systems in terms of their biomitigating potential. This is especially the case for integrated systems in open water, where environmental factors are difficult to control and direct measurements are not easy to permit (Troell et al., 2003).

Several seaweed species have been suggested as extractive candidates for integrated systems. However, results on their biomitigating potential are inconsistent, especially in open water systems (reviewed in Troell et al., 2003). This is among others the result of seaweed species, fed species and feed type used, but environmental factors are also thought to play a major role. The current study focusses on the effect of environmental factors on the biomitigating potential of seaweeds.

In open water systems, seaweeds are not only exposed to nutrients released by the fed species (i.e. waste nutrients), but also to nutrients which are already available in the environment (i.e. ambient nutrients). Waste nutrients are thought to differ from ambient nutrients in for example micronutrients and stoichiometry. Also the ratio between waste nutrients and ambient nutrients varies in time and space. The concentration of waste nutrients fluctuates for example as a result of feeding regimes (Jansen et al., in preparation) and local hydrodynamic conditions around cages causes that nutrient concentrations may vary on a small spatial scale (Broch et al., 2013). This is thought to influence the biomitigating potential of seaweeds.

Little information is available about the influence of the ratio between waste nutrients and ambient nutrients on the biomitigating potential of seaweeds. Therefore the aim of the current study is to investigate the interaction between environmental nutrient load and fish waste concentrations on the waste retention efficiency of seaweed in a fish – seaweed integrated system, using sea lettuce (*Ulva lactuca*) and sea bass (*Dicentrarchus labrax*) as model species.

Materials & Methods

Sea lettuce was cultivated indoors (15 l flow-through tanks), under controlled conditions (temperature $15.0 \pm 0.5^\circ\text{C}$, photon flux density $200 \pm 10 \mu\text{mol.m}^{-2}.\text{s}^{-1}$, photoperiod 12D:12L). Each seaweed tank was exposed to different ratios of ambient nutrients and fish waste nutrients (3 replicas per treatment). For the ambient nutrients 4 media were created, differing in nitrogen (N) and phosphorus (P) concentrations. These media simulated 4 environmental nutrients loads; nutrient poor (no nutrients added), oligotrophic environment (0.15 mg N.l^{-1} , $0.066 \text{ mg P.l}^{-1}$), mesotrophic environment (0.75 mg N.l^{-1} , 0.33 mg P.l^{-1}) and eutrophic environment (3.75 mg N.l^{-1} , 1.66 mg P.l^{-1}). Water from a RAS system (*D. labrax*) was used to create 4 fish waste concentrations; no fish waste (no RAS water added), low (0.08 mg N.l^{-1}), medium (0.8 mg N.l^{-1}) and high (8 mg N.l^{-1}). The 4 fish waste concentrations were combined with the 4 ambient concentrations, resulting in a 4×4 factorial design. Growth and tissue content (including stable isotopes analyses) of sea lettuce were determined and nutrient concentrations in the water were analysed, in order to investigate the effect of different ratios of ambient nutrients and fish waste nutrients on the biomitigating potential of sea lettuce.

Results & Discussion

Results of growth and tissue content of sea lettuce exposed to different ratios of ambient nutrients and fish waste nutrients, will be presented. These results may contribute to a better understanding of the effect of environmental factors on the biomitigating potential of seaweeds in integrated systems. Outcomes of this study will be discussed in the context of ecological sustainability issues of IMTA systems, with the focus on open sea integrated systems.

References

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