OPTIMISATION OF STOCKING DENSITY AND FEED FORMULATION IN SEMI-INTENSIVE PRODUCTION SYSTEMS: HOW IT CAN MINIMISE THE ENVIRONMENTAL IMPACTS OF EARTH POND AQUACULTURE

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Introduction

The positive effects of semi-intensive aquaculture, including environmental protection and restoration in areas of ecological interest, employment opportunity and development of rural and coastal areas, have been widely recognised. Nevertheless, this type of aquaculture also presents major drawbacks. For instance, semi-intensive production systems often have low profit margins, as a result of its high production costs (e.g. high labour costs and high land costs) and low productivity (SEACASE 2007). A low profitability associated with the increasing competitiveness for space allocation and market competition, especially with products from intensive aquaculture, seriously compromise the economic sustainability of this activity. One way to increase the competitiveness of semi-intensive aquaculture and to provide added-value to its products is by optimising the production systems, while minimising the environmental impacts in the adjacent water bodies. With this purpose, and within the scope of the SEACASE Project (www.seacase.org), a case study was designed to test different improved production protocols in polyculture ponds of gilthead seabream (*Sparus aurata*) and sole (*Solea senegalensis*). Some of the goals of this study were to: i) evaluate the effects of different stocking densities and feed formulations on pond and effluent water quality and to ii) define acceptable ranges for water quality parameters in order to prepare an Environmental-Friendly-Allowing-Maximum-Production Protocol.

Material & Methods

At the IPIMAR Aquaculture Research Station, two trials were carried out in 7 earthen ponds with a bottom area of 400m^2 and a capacity of 750m^3. In the first trial (from April 2008 to February 2009), two different stocking densities were tested aiming at final productions of 1.5 (standard use in Portugal) and 3.0kg m^{-3}. In the second trial (from March 2009 to July 2009), an "environmental friendly" feed formulation was tested against a standard industrial feed, using the lower density ponds of the first trial as control. In both trials, two replicate ponds were used per treatment. The impact of farming protocols on pond and effluent water quality was evaluated by determining the physical, chemical and biological parameters of water samples collected at regular intervals, with special incidence in the warmer season.

Results and Discussion

High fish densities (3kg m^{-3}) tended to increase the amount of suspended particulate matter (SPM) in effluent waters, probably as a result of fish activity (faeces, uneaten feed or sediment re-suspension due to fish bioturbation). A Correspondence Analysis (CA) applied to the water chemical parameters of standard (SD) and high density (HD) ponds revealed that fish density also affects the composition of effluent waters, since organic nitrogen compounds (DON and urea) presented strong affinity with HD ponds, whereas inorganic compounds (NH_4^+, NO_3^- and HPO_4^{2-}) were highly correlated to the SD ponds (Fig. 1).

Feed formulation also had an impact on effluent water quality, since lower concentrations of phosphorus compounds (HPO_4^{2-} and DOP) were found in the effluent waters of the ecofeed ponds, most likely due to the lower content of soluble phosphorus in this ration (SEACASE 2007). In the feed trial, no significant differences (Wilcoxon test, $p<0.05$) were found for SPM in ponds with standard and ecofeeds, possibly due a similar fish biomass in these ponds (Hargreaves 1998, Avnimelech 1999).

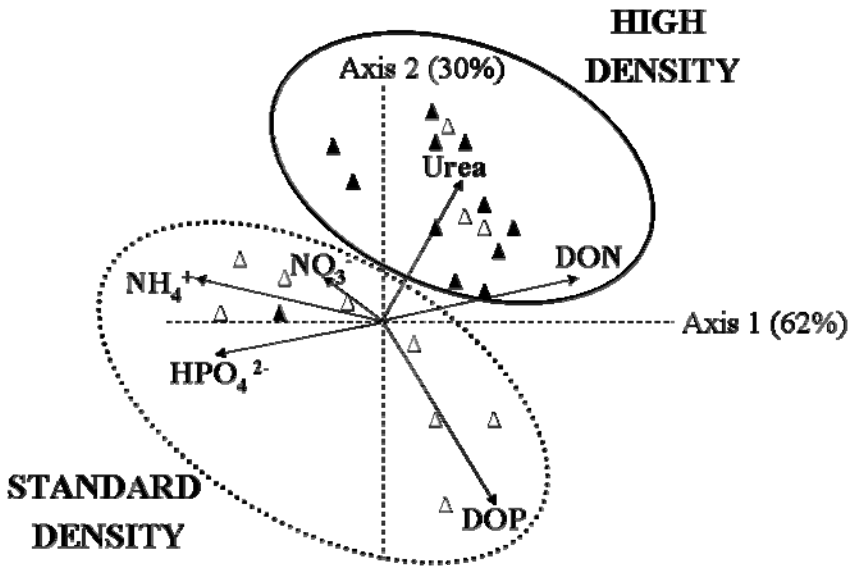

Fig. 1. Correspondence analysis (CA) ordination plot for the chemical parameters (NH_4^+ - ammonium, NO_3^- - nitrate, DON – dissolved organic nitrogen, Urea – Ur, HPO_4^{2-} - phosphate and DOP – dissolved organic phosphorus) of effluent waters from standard (Δ) and high (▲) density ponds.

Conclusions

Although fish density and feed formulation affected the composition of effluent waters, the physical, chemical and biological parameters determined in the experimental ponds were within the normal ranges found in the Ria Formosa lagoon (Falcão and Vale 2003), suggesting that the farming protocols were environmentally sustainable. This information may help defining a good practices code for semi-intensive fish production in earth ponds, and contribute to minimize the environmental impacts of this activity.

References

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SEACASE (SUSTAINABLE EXTENSIVE AND SEMI-INTENSIVE COASTAL AQUACULTURE IN SOUTHERN EUROPE) [on-line]. Available at: http://www.seacase.org