



INSTITUTIONEN FÖR BIOLOGI OCH MILJÖVETENSKAP

*A circular economy approach for sustainable feed
in Swedish aquaculture: A nutrition and
physiology perspective*

James Hinchcliffe

Institutionen för biologi och miljövetenskap
Naturvetenskapliga fakulteten

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Dissertation abstract

One major challenge in aquaculture is the issue of fishmeal replacement as a protein source in aquafeeds. It is agreed that the rate of demand has now outpaced the rate of supply due to the rapid expansion of aquaculture. In Sweden, work is being done to establish a knowledge base for the development of sustainable marine aquaculture, focusing on two species: Atlantic wolffish, *Anarhichas lupus* and European lobster, *Hommarus gammarus*, as well as on two novel protein ingredients. The goal of this thesis was to contribute to a knowledge base for the farming biology and culture operations of the two species, with a circular economy model and minimal environmental impact in mind in line with UNs agenda 2030.

In paper I, work was done to optimize the pH-shift process, a novel protein extraction technology with potential to produce a highly concentrated protein ingredient from industrial seafood by-products. Three combinations of herring by-products were chosen along with two different process settings and differences in final proximate composition were characterized. Results showed the alkaline version of the process gave significantly higher protein yields and all forms of by-products were deemed as promising.

Paper II initiated four feeding experiments (novel feed types, feeding regime and feed size and cannibalism effects) on growth and survival, to inform and update husbandry protocols in *H. gammarus*. Overall, we found that feed offered six times daily, small-grade dry feed (250–360 µm) and larvae fed different proportions of dry feed and/or conspecifics in both communal and individual rearing systems all improved growth and survival rates. This underlines the impact of cannibalism on survival in *H. gammarus* larviculture.

In paper III we examined the suitability of locally produced, novel protein sources from by-products on the growth of recently metamorphosed post-larva. We found that, that a diet containing a proportion of shrimp, created from local industry by-products, was the best source of a sustainable lobster feed for the emerging lobster aquaculture sector.

The nutritional requirements of Atlantic wolffish are not known. In paper IV six experimental diets were formulated to test differing protein increments, 35-60%. We found that there was a high protein requirement in the diet (50-60%) but observations suggested that individual wolffish were able to compensate for this by increasing individual feed intake.

The aim of paper V was to establish the stress response of Atlantic wolffish exposed to an acute and chronic temperature challenge. Overall we found evidence confirming a stress response in selected parameters, suggesting that at 15°C, the high allostatic load of this temperature leaves no scope for growth. However, no evidence of a primary stress response (cortisol) could be found, suggesting that cortisol may not be a good parameter to measure welfare in this species in future studies and aquaculture operations.

Keywords: Sustainability, aquaculture, aquafeeds, wolffish, European lobster

