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Aquafeeds

CSIRO studies dry feeds for juvenile spiny lobsters

Friday, 1 October 2004

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Excellent growth, survival rates with pelleted feeds



Tropical spiny lobsters are grown out in staked sea cages in Vietnam.

The culture of tropical spiny lobsters (*Panulirus ornatus*) is a flourishing industry in Vietnam that had a farm gate value of about U.S. \$75 million in 2001-02. Seed lobsters harvested from the wild and ongrown in sea cages grow to a market size of about 1 kg in 15-18 months.

Currently the lobsters are fed solely on fresh fishery bycatch, but its continued use is unsustainable due to competitive pressure caused by declining inshore fishery catches, poor feed conversion, and negative environmental impacts. The development of high-performing, pelleted lobster feeds is a high priority for long-term industry sustainability.

Australia studies

With the financial support of Australia's Fisheries Research and Development Corp., the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Queensland, Australia, has carried out research on pelleted dry feeds that are palatable to juvenile tropical spiny lobsters and result in excellent growth and survival rates. The work will assist in the development of a spiny lobster aquaculture industry in Australia.

Diet development

Following preliminary studies to determine feeding behavior and responses to gross nutritional manipulation, four experiments were carried out to establish the lobsters' requirements for critical nutrients and determine the chemical cues that stimulate sustained feeding. A summary of the experimental procedures is given in Table 1.

Irvin, Summary of experimental procedures, Table 1

Objective	Experiment 1 Protein, Lipid Required	Experiment 2 Leachate, Preference	Experiment 3 Protein Required	Experiment 4 Astaxanthin Required
Tank volume (l)	400	400	400	400
Initial weight (g)	2	5, 80 *	2	18
Lobsters/tank	10	7-10	8	7-10
Duration (days)	84	126	56	84
Replicates	4	4	4	4

Table 1. Summary of experimental procedures.

Lobsters were obtained from wild populations in Trinity Inlet, Cairns. The aerated tanks were supplied with flow-through seawater of 33 to 35 ppt salinity filtered to 20 μ and heated to 29 \pm 0.5 degrees-C. Sufficient hiding areas were provided for all lobsters.

Dietary protein and lipid

The initial experiment tested the growth response of juvenile lobsters to different levels of dietary protein and lipid. The pelleted diets were initially readily accepted by the lobsters. A clear dose response to protein was exhibited, with maximum growth responses at 47 and 53 percent dry matter crude protein for the 6 and 10 percent lipid diet series, respectively. However, the growth rates were below those observed in the wild or when lobsters are cultured on fresh fishery products (Fig. 1). The poor growth on the pelleted feeds was attributed to a decline in the attractiveness of the pellets within a short time of their immersion in water.

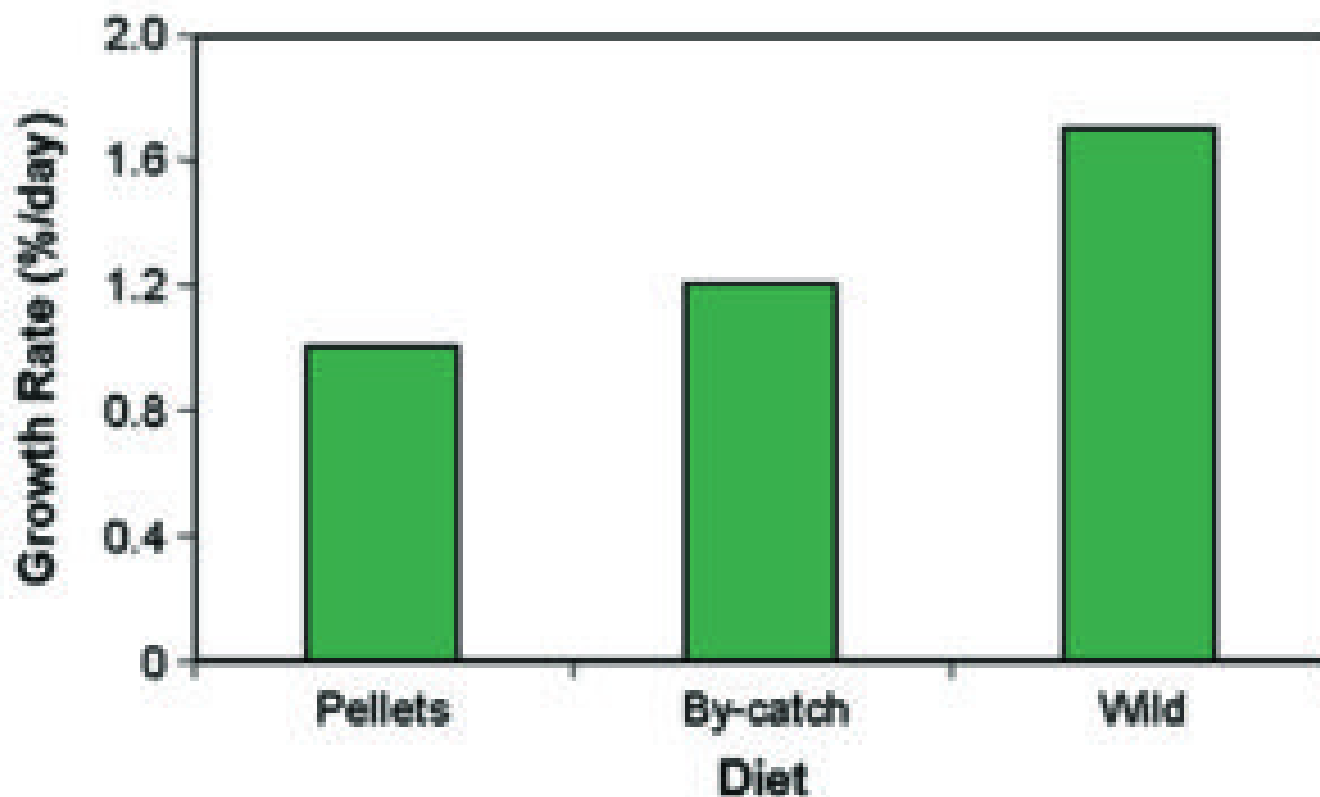


Fig. 1. Specific growth rates of size-standardized *P. ornatus* fed the best pelleted dry diet or fresh by-catch, and those recorded in wild *P. ornatus* using tag and release procedures.

Preference testing

A second experiment addressed the question of how to sustain the lobsters' interest in the pelleted feed. Fresh food items were included in pelleted feed as a source of natural chemical feeding cues and to relate the rate at which the chemicals leached from the feed to changes in the lobsters' preferences.

Green-lipped mussels, school prawns, polychaete bloodworms, and squid were singularly included in the feed as homogenates at a rate equivalent to 5 percent dry matter. The rates at which dry matter, soluble and nonsoluble protein, and individual free amino acids leached from each feed and a frozen green-lipped mussel control were characterized for an immersion time of 7.5 hours.

Each of the test feeds including the control was pair tested against a commercially extruded Karuma shrimp feed previously shown to have high acceptance by the lobsters. Lobsters preferred the mussel control over that of all other feed types, whether fed fresh or after immersion in water for five hours.

Comparison of the relative intake of each feed type against the rates at which nitrogenous compounds leached from the immersed feed showed strong correlations for soluble protein and the free amino acids taurine and glycine. The authors concluded from these results that increasing the supply and prolonging the release of peptides and free amino acids from pelleted feeds was likely to prolong the lobsters' feeding.

Dietary protein optimization

In the third experiment, which reevaluated the dietary protein specification for juvenile spiny lobsters, dried whole krill and krill hydrolysate were included in the dietary formulation as sources of the small peptides and free amino acids most likely to stimulate sustained lobster feeding responses. Feeding frequency was increased from two to four daily feeds. Fresh green-lipped mussel was included in the treatment array as a reference diet.

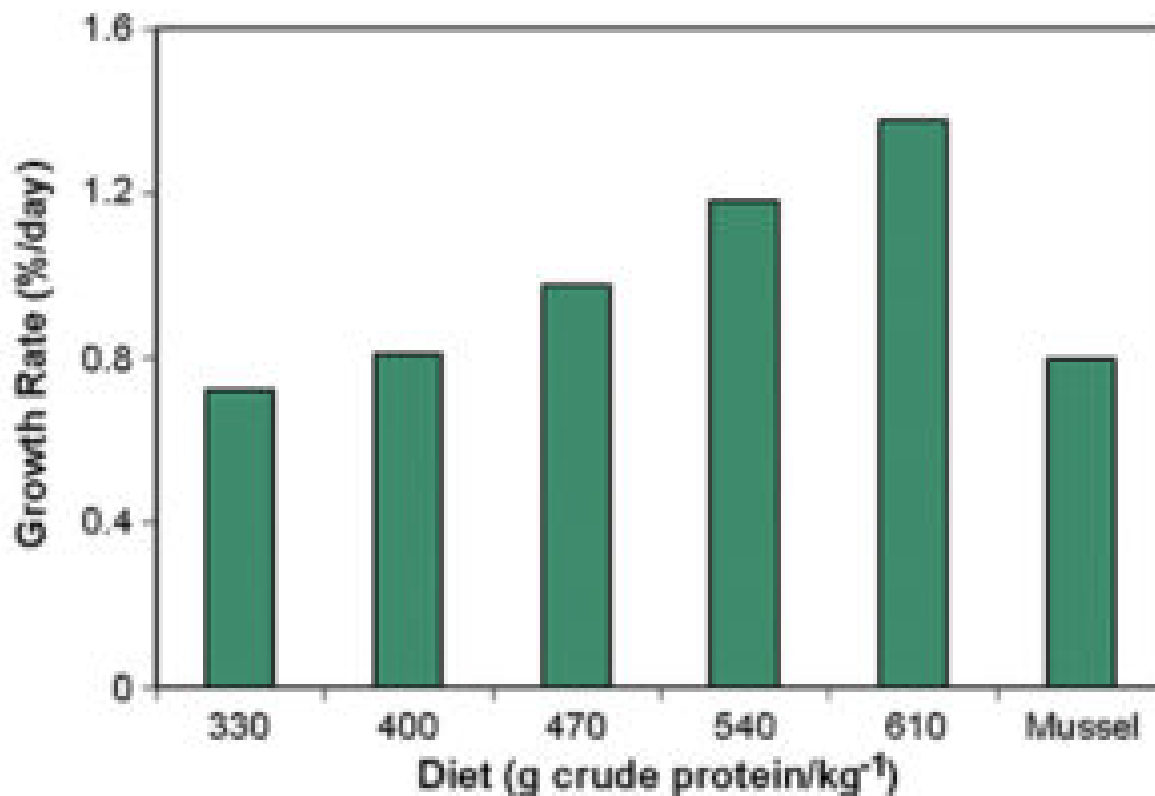


Fig. 2: Specific growth rate of spiny lobsters fed pelleted feeds with incremental amounts of dietary crude protein or fresh mussels.

A clear dose response to increasing dietary protein content was observed. Lobsters fed the highest-protein diets achieved excellent growth significantly better than those fed fresh mussels (Fig. 2). Since lobster growth rose linearly with increasing dietary protein to the maximum amount investigated, it was not possible to determine an optimal dietary protein specification.

It was clear that lobsters require high-protein diets with at least 60 percent crude protein for high rates of growth. In the lobsters fed on mussels, growth rate and survival were depressed in the final four weeks of the experiment. The majority of deaths occurred during molt, while the exoskeleton pigmentation of the surviving lobsters fed mussels was pale.

Dietary carotenoid optimization

Because of the low survival and color of lobsters fed green-lipped mussels in the third experiment, the objective of the fourth experiment was to determine the optimum dietary carotenoid specification for juvenile spiny lobsters.

Astaxanthin was added to a basal formulation containing total carotenoids of 30 milligrams per kilogram at incremental rates of 25 milligrams per kilogram to make four pelleted diets with carotenoid content ranging 30 to 105 milligrams per kilogram. The diets were fed to juvenile lobsters for 12 weeks and compared to two fresh reference diets of green-lipped mussels and blue mussels.

Increasing the astaxanthin content of the feed had no significant effect on lobster growth or survival, but correlated with an increase in the astaxanthin concentration of the lobsters' body tissues and darkening of their exoskeletons. Again, lobsters fed pelleted diets grew significantly faster than those fed the mussel diets. A depression in growth after six weeks of feeding was observed in the lobsters fed mussels. Dietary inclusion of 50 milligrams astaxanthin per kilograms feed is advocated for good coloration and nutritional support for enhanced immunocompetence and stress resistance.

Problems with the mussel diets were likely due to micronutrient deficiency. Lobsters generally contain stores of critical micronutrients, with poor growth and mortality only exhibited after the stores are depleted.

Results from this experiment suggested the poor performance in animals fed mussels was not due to an insufficient supply of carotenoid, but other nutrient problems – perhaps cholesterol deficiency or increased vitamin loss due to the prior freezing of the mussels. In contrast to other studies with temperate spiny lobsters, frozen mussels were found unsuitable as a sole diet for tropical spiny lobsters.



Cultured lobster at harvest size.

Future work

A dry pelleted feed has been developed for tropical lobsters that produces excellent growth and outperforms a sole diet of frozen mussels. Using this feed as a benchmark, future work will concentrate on establishing requirements for micronutrients such as cholesterol and finding ways to reduce the inclusion rate of expensive marine protein ingredients without lowering diet performance.

(Editor's Note: This article was originally published in the October 2004 print edition of the Global Aquaculture Advocate.)

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