

vival of *Penaeus monodon* juveniles (PL₅₀; carapace length, 4.01 mm; body weight, 0.053 g) were studied in 80-l glass aquaria. The treatments were: (a) a commercial pellet (40% protein); (b) live *Ruppia*; (c) decaying *Ruppia*; (d) live *Najas*; and (e) decaying *Najas*. The pellet was offered to satiety (approx. 100% of body weight) twice daily. Live *Ruppia* and *Najas* were transplanted in the aquaria using pond soil a week prior to the experiment. Decaying *Ruppia* and *Najas* were transferred from ponds. Salinity was maintained at 15 ppt and 50% of the water was changed regularly.

Highly significant differences ($P < 0.01$) in mean carapace length (CL) and mean body weight (BW) on the 10th, 20th and 30th days were observed among treatments. Increase in CL was fastest with decaying *Najas* and slowest in live *Ruppia* (14% vs. 17% after 30 days). Growth with decaying *Ruppia* was comparable to pellets on the 10th and 20th days but was faster after 30 days. Body weight on all sampling days was highest in decaying *Najas* and lowest in live *Ruppia*. Percentage increases were 122, 273 and 565% on the 10th, 20th and 30th days, respectively, with decaying *Najas*. Those given live *Ruppia* registered increases of 11, 67 and 94%, respectively. The rapid growth rate of animals on decaying *Najas* was compensated negatively by a low survival rate (31%), significantly lower than on live *Najas* (100%). Other survival percentages were: decaying *Ruppia*, 59% and pellet, 53%.

Hepatopancreas Cells as Monitor Cells for the Nutritional Value of Prawn Diets in Aquaculture

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The hepatopancreas is considered to be the central organ of metabolism in decapod Crustacea. It is a system of blind tubules consisting of four cell types. The E-cells at the summits of the tubules develop into R-cells (for resorption of nutrients), F-cells (for production of digestive enzymes) and B-cells (function unknown).

The ultrastructure of *Penaeus monodon* R-cells changes largely after starvation and feeding different diets. B-cells show slight reactions, while F- and E-cells are rather constant. Thirteen day-starvation results in a large decrease of the cell size and in a significant reduction of all cell organelles. After seven days starvation and four days refeeding with various extreme diets, the R-cells develop completely different food-specific ultrastructures. A distinct proliferation of the endoplasmic reticulum is characteristic of

protein diets. Large fat drops are the main feature after refeeding with cod liver oil. Sucrose feeding results in "empty" cells with only few organelles. The most diversified ultrastructure with fat droplets and a high amount of all cell organelles is obtained by feeding a mixed diet.

The study indicates that R-cells are very sensitive to the application of different diets. They could be used as monitor cells for the nutritional value and the availability of a diet for prawns. Particularly poor or badly formulated feed could be detected early by electron microscopy. This method may be very helpful for the development of artificial prawn diets in aquaculture, especially if natural sources will be used as food components.

Effect of Cholesterol in Artificial Diets for Mediterranean Prawns

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Mediterranean prawn (*Penaeus kerathurus* Forsskal) postlarvae (2 months old) were fed *ad libitum* with previously tested artificial diet (41% D.W., mainly of vegetal origin) supplemented with different percentages of cholesterol (0, 0.1, 0.5, 1.0 and 3.0%) and fresh bivalve mussel. Growth and survival rates were determined twice.

Considering supplemented formulas only, data show that: (a) individual weights were higher with 0.1% cholesterol in the diet; (b) survival sharply dropped in the last week of the experiment, in particular with 0.1 and 3.0% cholesterol diets; and (c) with 1.0% cholesterol, mortality and growth counter-balanced giving over-all better results.

No artificial feed can compete with the natural diet, either for survival rate or for individual growth.

Evaluation of Artificial Feeds for Shrimp (*Penaeus monodon*) Production in Brackishwater Ponds

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The experiment was conducted in fifteen 500-m² brackishwater ponds to determine the response of *Penaeus monodon* juveniles fed with various artificial diets. Five treatments with three replicates each were: two commercial feeds containing 45% and 40% crude protein (treatments I and II), two experimental diets formulated to contain 35% crude protein (treatments III and IV) and control, without

feeding (treatment V). Shrimp were fed twice daily at feeding rates based on shrimp consumption.

Highest mean harvest weight was attained in treatment I (23.47 g) > III (19.25 g) > II (18.86 g) > IV (11.29 g) > V (9.27 g). Statistical analysis showed that differences in growth were significant at 5% probability level. However, growth in treatments I, II and III are comparable, also growth in treatments II, III and IV. Growth in treatments I, II, III and IV was significantly different from treatment V. Highest mean survival was attained in treatment III (91.82%) > I (88.93%) > II (86.95%) > IV (83.62%) > V (82.62%). Statistical analysis showed no significant differences among treatments at 5% probability level.

Projecting on a hectare basis, mean yield for each treatment was: I (628.37 kg) > II (496.35 kg) per crop in 120 days culture. Good yield was attributed to provision of formulated feeds, use of pumps in addition to tidal change for water exchange and control of predators, and pest eradication through proper pond preparation.

Staggered Harvesting as a Method of Increasing Prawn Production with Supplemental Feeding

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Prawns, like any other animals, exhibit dissimilarities in growth rates. As they grow, a wide range of body weight distribution from the same population is observed. Staggered harvesting method is commonly practised in cultured animals having this characteristic. Selective or partial harvesting is especially useful in this type of management system. In this case, the larger shrimps are caught earlier than the small ones thus giving chance for the smaller ones to grow bigger.

The study was conducted in four one-ha ponds. Recommended pond preparation was followed. Partial harvesting was employed in experimental ponds by using 2-4 units of 8 knots selective pound nets once a week commencing after three months culture until final harvest. Control ponds were harvested only once at the end of the culture period.

The results show a mean production value of 506 kg from control ponds and 639 kg from experimental ponds. Average

survival rate for experimental ponds was higher (92.90%) than for control (77.65%). Final average body weight was higher for experimental ponds (21.8 g) than for control (20.5 g).

Size-wise, production of big size group (30-35 g) is 578.0 kg compared to 434.6 kg for small size group (13.1-13.4 g) from both control ponds with over-all production of 1,012.6 kg. On the other hand, production from the two experimental ponds for big and small size groups is 872.2 and 405.8 kg, respectively. The means of the total weights of marketable size *Penaeus monodon* from control and experimental ponds are 289.0 and 436.1 kg, respectively. That is, 43.5% of the stock reached marketable size in ponds with staggered/partial harvest method compared to only 27.5% from control ponds.

The Production Economics of an Integrated Prawn Hatchery-Floating Nursery Project

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The paper aims to present an economic evaluation of an integrated prawn (*Penaeus monodon*) hatchery-floating nursery project using standard economic tools and methods of analysis. The data used in the analysis were taken from SEAFDEC AQD experience at the Batan, Aklan Research Substation hatchery-floating nursery project. The technical bases were gathered from researchers after the peculiarities of aquaculture *vis-a-vis* other business ventures in agriculture and industry were taken into consideration.

The study shows that an integrated hatchery-floating nursery project is a profitable culture system. The rate of return on investment for this integrated project ranges from 29 to 47% while payback period ranges from 1.8 to 2.6 years. A separate economic analysis of a hatchery project and a floating nursery was also undertaken to determine the profitability of independently operating each subsystem. The analysis shows better results for the floating nursery subsystem as compared to the hatchery subsystem. Return on investment and payback period for the floating nursery range from 23 to 78% and 1 to 3 years, respectively, while those for the hatchery range from 20 to 36% and 2.3 to 3.7 years, respectively.