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Aquafeeds

Mixed maturation diets improve shrimp broodstock performance

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Mixture of fresh feeds, dry broodstock pellet results in lower broodstock mortality for male and female *P. vannamei*

P. stylirostris broodstock (without striped coloration) fed a 50/50 mix of fresh and pelleted feed provided quality offspring through repeated spawnings.

Interest in captive reproduction of penaeid shrimp is increasing worldwide due to the urgent need to establish selective breeding programs and produce certified, diseasefree postlarvae. An optimal diet is a crucial factor in the successful sexual maturation and reproduction of shrimp in breeding operations. High-quality food represents the highest operational cost in most broodstock management facilities. Maturation facilities in marine shrimp hatcheries depend mostly on fresh feeds, which can be inconvenient for operators. Dry artificial feeds, on the other hand, have several advantages, including reliable supply, consistent and controlled quality, and ease of handling. Artificial diets also reduce fouling of larval tanks, cut risk for disease transfer, and offer effective delivery of chemotherapeutics, immunostimulants and hormones. Trials in Ecuador and New Caledonia indicated that the incorporation of artificial feeds in broodstock diets can improve broodstock performance in several areas.

A dry, off-the-shelf broodstock feed was formulated to provide optimal palatability, stability, and nutrition for broodstock shrimp (Table 1). The diet contains no marine protein sources derived from aquaculture, and provides a constant supply of all known essential nutrients for broodstock maturation. These include highly unsaturated fatty acids of the omega-3 and -6 families, phospholipids, cholesterol, carotenoids, vitamins, minerals, artemia and squid factors. The combination of appropriate extrusion and binder technology resulted in high water stability.

Coutteau, Nutritional profile of INVE Breed-Shrimp, Table 1

Component	Unit	Specifications
Moisture	%	< 10
Crude fiber	%	< 4
Crude protein	%	> 50
Crude fat (hydrolysis)	%	> 10
Essential Fatty Acids		
ARA (20:4n-6)	mg/g DW	> 1.5
EPA (20:5n-3)	mg/g DW	> 5
DHA (22:6n-3)	mg/g DW	> 10
n-3 HUFA (≥ 20:3n-3)	mg/g DW	> 20
n-6 PUFA (≥ 18:2n-6)	mg/g DW	> 10
Vitamin C	mg/kg	> 3,000
Vitamin A	IU/kg	> 20,000
Vitamin D3	IU/kg	> 8,000
Vitamin E	mg/kg	> 800

Table 1. Nutritional profile of INVE Breed-Shrimp broodstock feed.

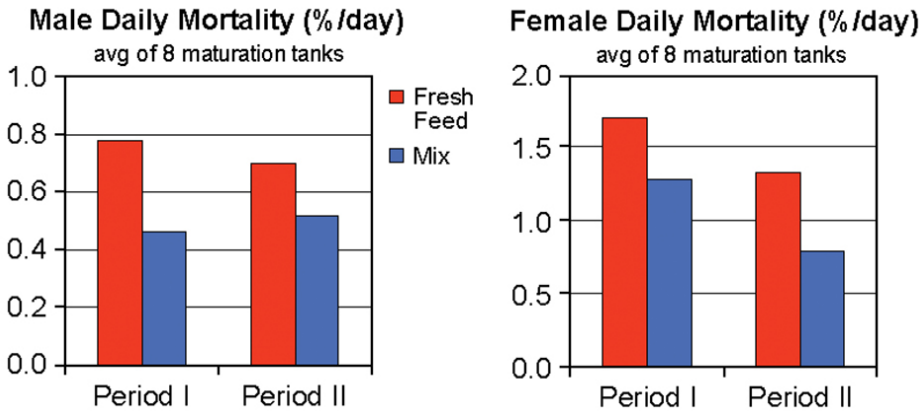

Fig. 1: Average daily mortality during a 39-day maturation trial with *Penaeus vannamei* broodstock fed fresh feeds or a mixture of fresh and dry feeds. During the last two weeks (Period II), both groups received 80 percent fresh and 20 percent dry feed.

Maturation test with *P. vannamei*

The feed was evaluated under commercial conditions as a partial substitute for fresh feeds during a 39-day maturation trial with *P. vannamei* at the Quirola Group's Quimasaru hatchery in Ecuador. The experiment used 16 maturation tanks (eight per treatment), each stocked with approximately 80 wild-caught shrimp at a sex ratio 1:1. Shrimp of 40 grams average body weight were acclimated and ablated prior to stocking. Natural photoperiod was used, with a 50 percent daily water exchange and temperature of 29 to 30 degrees-C.

During Period I, the first 19 days of the experiment, shrimp in the control tanks were fed solely on a mixture of fresh feeds that included enriched artemia biomass, mussels, squid, bloodworms, and shrimp heads. Contrary to current practice, the shrimp heads and other potentially risky feed elements were included because there was no white spot syndrome virus alert at the time of the trial.

The other group was fed a reduced ration of fresh feeds in combination with the dry pellets. Overall, fresh feed replacement approximated 50 percent on a dry-matter basis, but was different for each type of fresh feed fed to the control tanks.

During the experiment, the hatchery operator wanted to benefit from the reduced mortality due to the supplementation of the broodstock feed. Therefore, the two groups were switched to the same feeding regime in the final period. Both groups received a mixture of about 80 percent fresh feeds and 20 percent dry pellets during Period II, the last two weeks of the experiment.

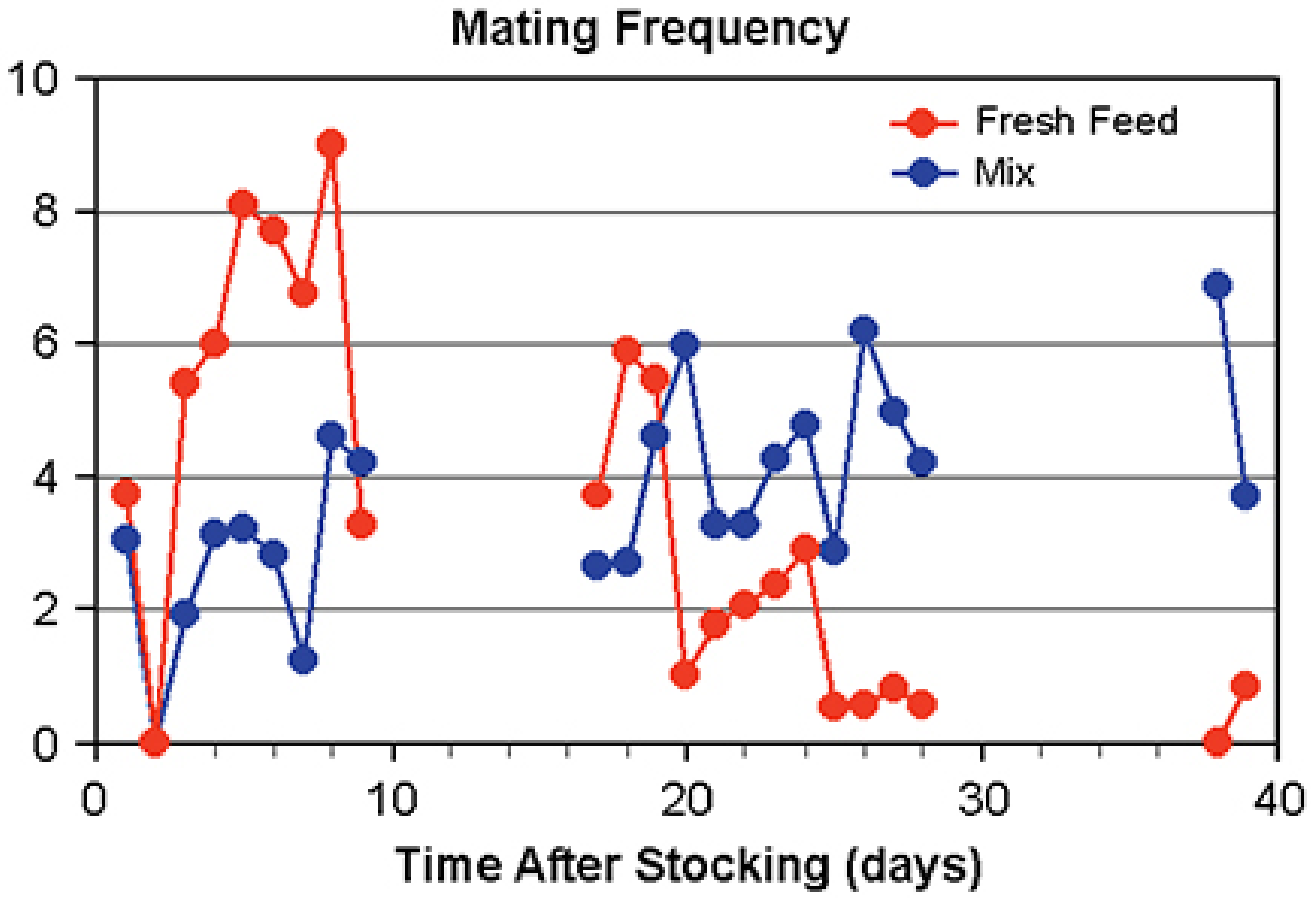

Fig. 2: Mating frequency during a 39-day maturation trial with *Penaeus vannamei* broodstock fed fresh feeds or a mixture of fresh and dry feeds. During the last two weeks, both groups received 80% fresh and 20% dry feed.Observations were discontinued during periods between production runs.

Mortality

High mortality after ablation of wild broodstock, with higher mortality observed in females, was an important problem during production runs. During Period I, animals fed the mixed diet had lower mortalities than animals fed just the fresh diet (Fig. 1). During Period II, overall mortality rate was reduced, and the effect of the dry feed supplement during the previous period remained important.

Mating

Mating frequency (daily percentage of females fertilized, through artificial insemination or natural mating) was considerably higher during Period I for broodstock fed the fresh feed (Fig. 2). The proportion of natural insemination was 40 to 55 percent. However, during Period II the percentage of successfully fertilized females dropped in the shrimp fed fresh feeds. Overall, a more consistent mating throughout the production run was obtained in the group that received the supplemented broodstock feed.

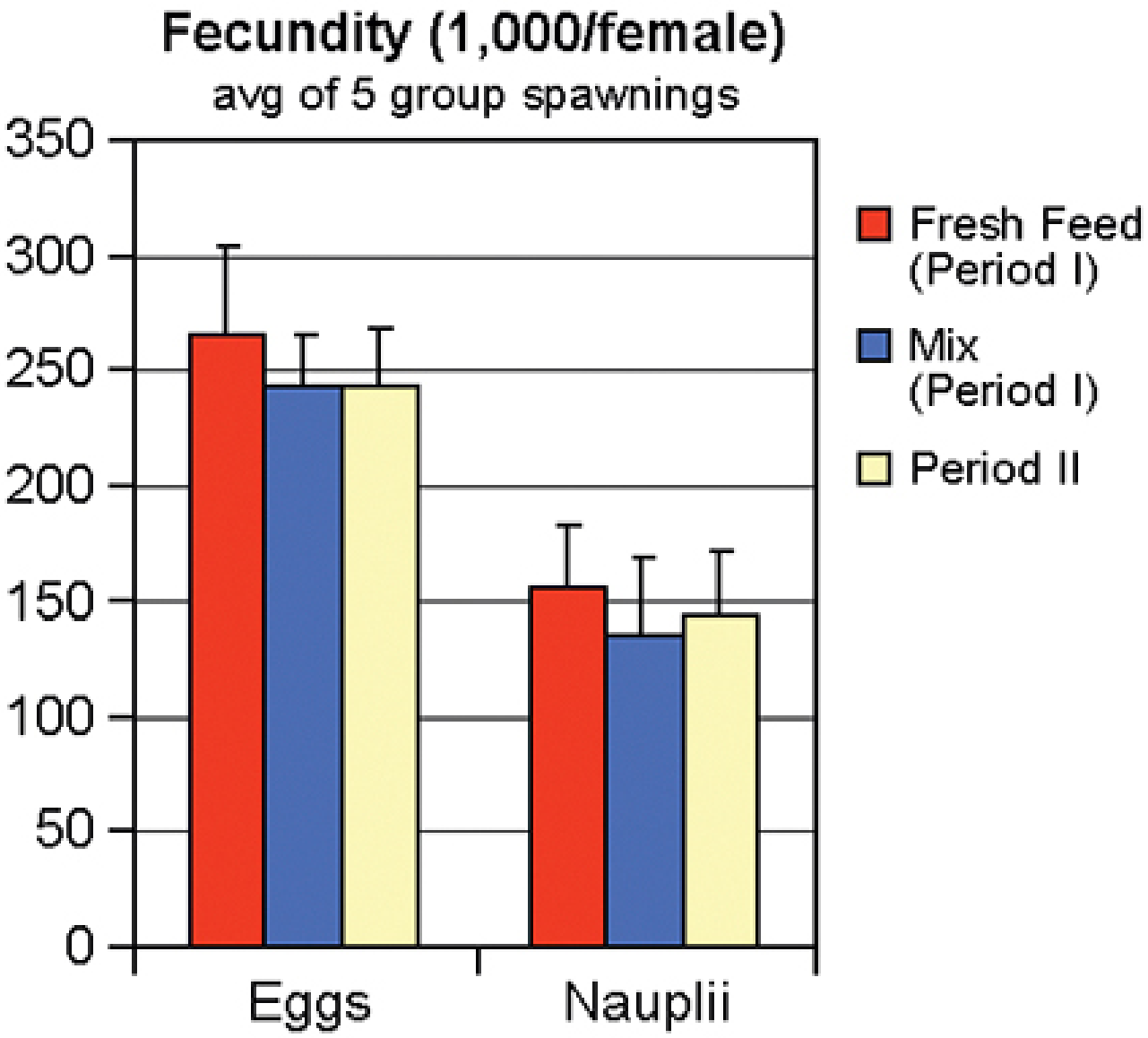

Fig. 3: Average fecundity from group spawnings during a 39-day maturation trial with *Penaeus vannamei* broodstock fed fresh feeds or a mixture of fresh and dry feeds.

During Period I, average fecundity of 245,000 eggs and 135,000 nauplii/female for the broodstock fed the mixed diet compared to 260,000 eggs and 152,000 nauplii/female for animals fed solely fresh feed (Fig. 3). This reflected 9 percent lower egg production and 14 percent fewer nauplii (no significant differences) in the group fed the mixed diet.

Fertilization percentages, which averaged 58 to 60 percent, were similar in both treatments. During Period II, average fecundity remained at an intermediate level compared to Period I (243,000 eggs and 144,000 nauplii/female).

Maturation test with *p. stylirostris*

Three trials were run with *P. stylirostris* at La Station d'Aquaculture de Saint-Vincent, an IFREMER facility in New Caledonia. Females were held at three animals per square meter in round, 4-meter-diameter tanks under typical maturation conditions of 29 to 30 degrees-C, with 50 percent water exchange/day and reversed photoperiod. Eyestalk ablation was performed.

The control feeding regime consisted of a mixture of fresh feeds (squid, mussels, and shrimp) and a small ration of dry commercial pellets. In the experimental regime, 50 percent of the fresh feed was replaced by the dry broodstock feed INVE Breed-Shrimp (Table 2).

Coutteau, Dietary regimes tested for maturation, Table 2

Treatment	Squid	Mussels	Shrimp	Dry Pellet	Broodstock Feed
Fresh feed	7.3%	6.1%	2.5%	0.5%	0%
50/50 diet	3.7%	3.1%	1.2%	0.5%	2%

Table 2. Dietary regimes tested for maturation of *P. stylirostris* (% shrimp body weight).

No major difference in overall performance between the two dietary regimes was noticed over 18 days during the trials (Table 3). However, some interesting effects were observed in successive spawns. Fertilization rate and number of nauplii per spawn, which did not show global differences between treatments in any of the trials, decreased in trial 1 with successive spawns in the fresh feed regime, whereas these parameters improved with successive spawns in the mixed dietary regime (Fig. 4).

Coutteau, Average female performance and nauplii quality, Table 3

Parameter	Fresh Feed	50/50 Mix
Female Performance		
Female survival %	60 ± 33	59 ± 18
Maturations/month/female	3.2 ± 1.1	3.4 ± 1.4
Eggs/female/spawn (x 1,000)	251 ± 57	241 ± 50
Fertilization %	55 ± 11	53 ± 14
Hatching %	74 ± 16	73 ± 19
Nauplii/female/spawn (x 1,000)	112 ± 19	99 ± 20
Nauplii Quality		
Deformity index (0-5)	4.7 ± 0.2	4.8 ± 0.1
Activity index (0-5)	4.7 ± 0.1	4.8 ± 0.1
Survival to zoea I in culture (%)	65 ± 8	75 ± 11

Table 3. Average female performance and nauplii quality for *P. stylirostris* broodstock fed fresh feeds or a 50% ration of fresh feeds combined with a broodstock pellet.

Also, although no significant differences could be detected in overall survival rate from nauplii to zoea I, survival decreased drastically in the last week of the maturation trial in the fresh feed treatment. This was not the case for the 50/50 mixed regime (Fig 5). These results showed that the nutritional boost provided by the broodstock pellet supported more sustainable reproductive activity and goodquality offspring through repetitive spawnings.

Conclusion

A maturation diet consisting of a mixture of fresh feeds supplemented with a dry broodstock pellet produced lower broodstock mortality for male and female *P. vannamei* following ablation and more consistent mating throughout the production cycle than a diet of fresh feeds. Comparable fecundity and fertilization rates were recorded for both feed types in trials.

The replacement of 50 percent of fresh feed with dry feed for *P. stylirostris* broodstock resulted in similar female reproductive response rates and similar larval quality (deformities, activity, and survival) when compared to animals fed the control diet. The mixed diet also improved fecundity and larval quality over repeated spawnings.

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