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Aquafeeds

Trial finds extruded feeds superior to steamed pellets

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Shrimp capable of feeding on floating feeds within indoor clearwater culture systems

A feeding trial conducted by the authors in 2000 at the Oceanic Institute (OI) in Hawaii, USA tested the effects of extrusion processing on the nutritive value of pelleted feeds for shrimp. In the 12-week trial, part of OI's shrimp feeds research program supported by the Agricultural Research Service of the U.S. Department of Agriculture, 0.95-gram *Litopenaeus vannamei* were studied in an indoor, running-water tank system.

A laboratory pellet mill was used to prepare the control diets.

Dietary treatments

A total of eight dietary treatments were evaluated:

A. Sinking standard steam-pelleted diet (35 to 37 percent protein), 2.4 mm diameter
B. Floating extruded/spherical agglomerizer system (SAS) diet, 3.2 mm diameter
C. Sinking extruded/SAS diet, 1.6 mm diameter
D. Floating extruded diet, 3.2 mm diameter
E. Sinking extruded diet, 2.4 mm diameter

F. Floating commercial catfish diet (37 percent protein), 2.8 to 3.35 mm diameter
G. Floating commercial trout diet (42 percent protein), 1.5 to 1.8 mm diameter
H. Floating commercial trout diet (45 percent protein), 1.5 to 1.8 mm diameter

Diet A was processed at OI using a pellet mill. Diets B to E had the same feed formulation, but were processed by Extru-Tech Inc. in Sabetha, Kansas, USA, which reground the feed in a mill to pass through a 0.04 (1.0-mm) screen. Moisture was then added to the mashes in a conditioner prior to extruding to 35 to 40 percent moisture. The mashes were extruded with a 1.5-mm screen die.

Extruded 1.5- to 2.0-mm strands of sinking and floating feed were collected and transferred to a spherical agglomerizer system to form two types of feed. The other two sinking and floating diets were extruded with a 2-mm die. In addition to the above OI formulations, three commercial floating feeds were also evaluated.

Experimental setup

Each diet was fed to triplicate groups of shrimp for 12 weeks. Animals were fed by hand to satiation four times daily at 8 a.m., 11 a.m., 2 p.m. and 5 p.m. The water temperature during the experiment ranged 25.1 to 26.2 degrees-C, with a mean of 25.7 degrees-C.

Final weight, feed efficiency

Table 1 shows shrimp growth and feed performance over the experimental period. Treatment E produced the highest mean final body weight of shrimp (8.35 grams), followed by treatments C (8.17 grams), D (7.37 grams), B (7.21 grams), A (7.11 grams), F (3.26 grams), H (3.15 grams) and G (2.93 grams).

Table 1. Shrimp growth and feed performance over the 12-week experimental period.

Dietary Treatment	Diet A OI CPM Sinking	Diet B OI SAS Floating	Diet C OI SAS Sinking	Diet D OI Extruder Floating	Diet E OI Extruder Sinking	Diet F Catfish 35 Floating	Diet G Trout 40 Floating	Diet H Trout 45 Floating
Shrimp Weight								
Initial body weight (g)	0.96[a]	0.94[a]	0.93[a]	0.96[a]	0.96[a]	0.93[a]	0.96[a]	0.94[a]
Final body weight (g)	7.11[b]	7.21[b]	8.17[ab]	7.37[ab]	8.35[a]	3.26[c]	2.93[c]	3.15[c]
Shrimp Feed Intake								
Mean daily feed intake (g/shrimp/day)	0.21	0.14	0.19	0.13	0.19	0.15	0.15	0.13
Shrimp Growth Response								
Total weight gain (%)	646.7[a]	666.6[a]	783.2[a]	667.1[a]	767.0[a]	248.1[b]	586.6[b]	638.7[b]
Mean weekly weight gain (g/shrimp/day)	0.51[b]	0.52[b]	0.60[ab]	0.53[ab]	0.62[a]	0.19[c]	0.16	0.18[c]
Specific growth rate (%/day)	2.39[a]	2.42[a]	2.59[a]	2.43[a]	2.57[a]	1.48[b]	1.33[b]	1.42[b]
Shrimp Feed Utilization								
Feed efficiency (%)[1]	0.34[b]	0.52[a]	0.45[ab]	0.57[a]	0.45[ab]	0.14[c]	0.11[c]	0.12[c]
Protein efficiency ratio[2]	0.93[b]	1.47[a]	1.26[ab]	1.60[a]	1.25[ab]	0.39[c]	0.26[c]	0.26[c]
Feed protein efficiency (%)[3]	17.80[b]	25.91[a]	24.50[ab]	29.12[a]	22.30[ab]	5.93[c]	3.54[c]	3.18[c]
Tank Production								
Total food fed (g)	154.1	130.3	168.9	126.3	169.9	93.3	81.8	65.4
Tank food conversion ratio	2.96[a]	1.93[a]	2.25[a]	1.76[a]	2.23[a]	7.80[a]	12.19[a]	9.95[a]
Survival (%)	75.0[abc]	91.7[a]	88.9[ab]	94.4[a]	88.9[ab]	63.9[abc]	58.3[bc]	52.8[c]
Feed cost/kg production[4]	3.08	2.01	2.34	1.83	2.32	3.58	7.92	8.66

a, b mean values for components with the same superscripts are not significantly different ($P < 0.05$).
1 Feed efficiency = [final shrimp biomass (g) – initial shrimp biomass (g) x 100/total feed offered (g, as-fed basis)].
2 Protein efficiency ratio = biomass gain (wet weight basis, g)/total feed protein offered (g).
3 Feed protein efficiency = whole body protein gain x 100/shrimp feed protein offered.
4 Feed cost/kg shrimp production – using tank food-conversion ratio and feed costs of $0.46/kg for Diet 06, $0.65/kg for Diet 07, $0.87/kg for Diet 08, and a feed ingredient cost of $1.04/kg for the OI shrimp diet (the latter does not include processing costs).

Feed efficiency (final shrimp biomass – initial shrimp biomass x 100 per-feed offered) was highest for treatment D (0.57), followed by treatments B (0.52), C and E (0.45), A (0.34), F (0.14), H (0.12) and G (0.11).

Conclusion

The results of this study demonstrated the beneficial effect on shrimp growth of feeds produced with extrusion processing as compared with conventional steam-pelleted feeds. Moreover, they showed extruded and SAS-processed sinking feeds were superior to floating feeds on the basis of shrimp growth performance, and that the SAS processing method offered no additional advantage compared with extrusion or straight steam pelleting. The results also demonstrated that shrimp were capable of feeding on floating feeds within indoor clearwater culture systems.

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