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Temperature affects shrimp survival, feed conversion

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Kasetsart University trials compared how two temperatures affected Pacific whites

Lab trials at Kasetsart University found shrimp consumed more feed at the higher temperature but did not grow faster than shrimp held at a lower temperature.

Temperature changes can alter the growth, survival and feed conversion of cultured Pacific white shrimp (*Litopenaeus vannamei)*. To examine the effects of temperature on these performance factors, the authors performed studies with shrimp in the laboratory as well as at an intensive culture farm.

Laboratory tests

Laboratory trials at Kasetsart University in Thailand compared how two experimental temperatures affected Pacific white shrimp. Animals averaging 12 g each were stocked into aquariums with a salinity of 25 ppt at 10 animals/aquarium. During the first part of the trial, feed was given at 3 percent of shrimp body weight in three doses of 1 percent/day at 29 degrees-C, while at 33 degrees-C, feed was given ad libitum for two hours.

Three replicates were made for each temperature and feed dose. Then, in the second part of the lab experiment, feed consumption was compared for three experimental groups:
Group 1 – Temperature 29 ± 1 degrees-C and feeding at 3 percent body weight
Group 2 – Temperature 33 ± 1 degrees-C and feeding at 3 percent body weight
Group 3 – Temperature 33 ± 1 degrees-C and feeding at 36.5 percent more than 3 percent body weight.

Laboratory results indicated that average feed consumption was 36.5 percent higher at 33 than at 29 degrees-C (Table 1), although growth was similar at both temperatures (Table 2). However, at 33 degrees, survival was lower due to deterioration of the water quality. Levels of ammonia-nitrogen and nitrite-nitrogen were higher (Table 3), thus giving this group the highest FCR due to low survival. Also, when feed was restricted to 3 percent of body weight at 33 degrees, growth was lower, indicating the shrimp needed more feed to attain normal growth at this temperature.

Limsuwan, Feed consumption of L. vannamei, Table 1

	Feeding Time	Feed Intake (g) (33 ± 1° C) Replicate 1	Feed Intake (g) (33 ± 1° C) Replicate 2	Feed Intake (g) (33 ± 1° C) Replicate 3	Feed Intake (g) (29 ± 1° C) Replicate 1	Feed Intake (g) (29 ± 1° C) Replicate 2	Feed Intake (g) (29 ± 1° C) Replicate 3
Day 1	8 a.m.	1.70	1.70	1.60	1.20	1.20	1.20
	1 p.m.	1.60	1.60	1.70	1.20	1.20	1.20
	6 p.m.	1.70	1.70	1.70	1.20	1.20	1.20
Day 2	8 a.m.	1.53	1.53	1.60	1.20	1.20	1.20
	1 p.m.	1.65	1.65	1.55	1.20	1.20	1.20
	6 p.m.	1.63	1.63	1.65	1.20	1.20	1.20
Average		1.63	1.63	1.63	1.20	1.20	1.20

Table 1. Feed consumption of *L. vannamei* at different temperatures under laboratory conditions.

Limsuwan, Performance of L. vannamei, Table 2

Experimental Group	Average Body Weight (g)	Survival (%)	Weight Gain (g/day)	Feed-Conversion Ratio

Group 1 (29° C)	20.00 ± 1.25[a]	96.00 ± 4.00[a]	0.20 ± 0.02[ab]	1.82 ± 0.04[a]
Group 2 (33° C)	18.20 ± 1.98[b]	91.67 ± 0.57[a]	0.17 ± 0.21[a]	1.84 ± 0.30[a]
Group 3 (33° C+)	20.80 ± 2.15[a]	65.33 ± 11.55[b]	0.22 ± 0.14[b]	2.71 ± 0.10[b]

Table 2. Performance of *L. vannamei* at two experimental temperatures under laboratory conditions. Values in the same column followed by different letters are significantly different ($P < 0.05$).

Limsuwan, Concentrations of ammonia-nitrogen, Table 3

Rearing Period (days)	Temperature Treatment	Ammonia-Nitrogen (mg/L)	Nitrite-Nitrogen (mg/L)
	Group 1 (29° C)	0.61 ± 0.90[a]	4.67 ± 0.59[a]
7	Group 2 (33° C)	1.34 ± 0.29[b]	4.07 ± 1.48[a]
	Group 3 (33° C+)	0.86 ± 0.29[a]	4.45 ± 1.57[a]
	Group 1 (29° C)	0.67 ± 0.21[a]	7.49 ± 0.88[a]
14	Group 2 (33° C)	1.02 ± 0.33[a]	3.47 ± 3.82[ab]
	Group 3 (33° C+)	0.91 ± 0.42[a]	1.79 ± 1.63[b]
	Group 1 (29° C)	0.67 ± 0.72[a]	5.73 ± 8.04[a]
21	Group 2 (33° C)	1.08 ± 0.72[a]	66.67 ± 23.09[a]
	Group 3 (33° C+)	1.50 ± 0[a]	80.00 ± 0.87[b]
	Group 1 (29° C)	0.25 ± 0[a]	3.30 ± 4.12[a]
28	Group 2 (33° C)	1.08 ± 0.72[a]	58.20 ± 37.41[b]
	Group 3 (33° C+)	1.58 ± 1.37[a]	79.97 ± 1.31[b]
	Group 1 (29° C)	1.17 ± 1.58[a]	1.17 ± 0.75[a]
35	Group 2 (33° C)	1.52 ± 0.03[a]	79.67 ± 0.86[b]
	Group 3 (33° C+)	2.00 ± 0.87[a]	80.83 ± 0.58[b]
	Group 1 (29° C)	0.67 ± 0.72[a]	0.93 ± 0.57[ab]
42	Group 2 (33° C)	2.83 ± 0.29[b]	1.46 ± 0.23[a]
	Group 3 (33° C+)	2.25 ± 0.90[b]	0.63 ± 0.57[b]
	Group 1 (29° C)	2.08 ± 1.58[a]	0.28 ± 0.02[a]
49	Group 2 (33° C)	4.83 ± 0.28[a]	78.73 ± 2.36[b]

	Group 3 (33° C+)	3.16 ± 1.75[a]	0.57 ± 0.25[a]

Table 3. Concentrations of ammonia-nitrogen and nitrite-nitrogen during temperature trials under laboratory conditions. Values in the same column followed by different letters are significantly different ($P < 0.05$).

Field trials

Field trials took place at an intensive culture farm in Naozhou dao, Guandong Province, China. Six ponds with an average area of 0.25 ha were stocked at an average of 144 shrimp/m² to evaluate temperature and feed demand during the July-September cycle.

A commercial feed table was the main reference for the daily feed doses. Feeding adjustments were made based on evaluation of leftover feed in feeding trays and/or intestine color checks using a technique described by Dr. Carlos Ching. In Ching's method, overfeeding is identified when more than 10 percent of the guts sampled show the brownish color of artificial feed one hour before feeding. Underfeeding is suspected when intestines show more than 40 percent blackish color from natural food one hour after feeding.

Temperature and feed consumption data were taken over 40 days. Days 21 to 40 had higher temperatures, and days 41 to 60 had lower temperatures. Shrimp weights were sampled every few days to determine the average daily gains.

At average temperature ranges from 30.5 to 33.2 degrees-C during days 21 to 40, feed consumption was 30 percent above the amount suggested by the feed table, while at average temperatures from 28.6 to 30.4 degrees-C during days 41 to 60, consumption was similar to the table values (Table 4). On the other hand, average daily weight gains were similar during the whole production cycle (Table 5), but feed-conversion ratios were higher (1.64) for days 21 to 40 than the 1.26 average value at the lower temperatures of days 41 to 60.

Limsuwan, Feed consumption during two periods, Table 4

Days 21-40 Pond Number	Days 21-40 Minimum Temperature Ranges (° C)	Days 21-40 Maximum Temperature Ranges (° C)	Days 21-40 Feed Amount Above Table Values	Days 41-60 Minimum Temperature Ranges (° C)	Days 41-60 Maximum Temperature Ranges (° C)	Days 41-60 Feed Amount Above Table Values
2	30.6 ± 1.50[a]	33.0 ± 1.20[a]	30.1% ± 4.9[a]	28.8 ± 1.21[a]	30.7 ± 1.15[a]	1.5% ± 0.6[a]
4	30.8 ± 3.33[b]	33.6 ± 3.60[b]	29.1% ± 9.9[b]	28.4 ± 1.55[a]	30.0 ± 1.33[a]	3.7% ± 1.8[b]
6	30.0 ± 1.85[a]	32.7 ± 1.43[a]	29.5% ± 4.5[a]	28.1 ± 0.90[a]	29.9 ± 1.52[a]	1.6% ± 0.5[a]
8	30.8 ± 1.10[a]	33.5 ± 0.96[a]	31.2% ± 5.3[a]	28.9 ± 1.70[a]	30.7 ± 1.24[a]	1.3% ± 0.4[a]
10	30.4 ± 1.76[a]	33.1 ± 1.12[a]	29.7% ± 5.0[a]	28.3 ± 1.30[a]	30.0 ± 0.98[a]	0.8% ± 0.2[a]
12	30.7 ± 1.90[a]	33.5 ± 1.03[a]	30.2% ± 5.5[a]	29.3 ± 3.01[b]	30.8 ± 2.99[b]	1.4% ± 0.3[a]

Average	30.5	33.2	30.0%	28.6	30.4	1.70%

Table 4. Feed consumption during two periods of the same production cycle in the intensive culture of *L. vannamei*. Values in the same column followed by different letters are significantly different (P < 0.05).

Limsuwan, Growth and FCR, Table 5

Days 21-40 Pond Number	Days 21-40 Temperature Range (° C)	Days 21-40 Average Weight Gain (g/day)	Days 21-40 Feed-Conversion Ratio	Days 41-60 Temperature Range (° C)	Days 41-60 Average Weight Gain (g)	Days 41-60 Feed-Conversion Ratio
2	30.6-33.0	0.178	1.60	28.8-30.7	0.180	1.13
4	30.8-33.6	0.206	1.77	28.4-30.0	0.198	1.26
6	30.0-32.7	0.182	1.49	28.1-29.9	0.190	1.15
8	30.8-33.5	0.197	1.65	28.9-30.7	0.205	1.30
10	30.4-33.1	0.188	1.68	28.3-30.1	0.197	1.38
12	30.7-33.5	0.155	1.62	29.3-30.8	0.199	1.35
Average	30.5-33.2	0.184	1.64	28.6-30.4	0.195	1.26

Table 5. Growth and FCR at different temperature ranges during intensive culture of *L. vannamei*.

Water deterioration was observed during the high-temperature period. Layers of dead microalgae appeared on the surface of the pond, and organic matter increased on the bottom. This is due to higher feed doses at higher temperatures, where feed supplied excess nitrogen and phosphorus to the pond and caused increases in algae. Later, when temperature decreased and feed doses were lower, the dead microalgae disappeared. It was also observed that at higher temperatures, dissolved-oxygen concentrations decreased but were never below 3.0 mg/L.

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