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Temperature affects feeding behavior of Pacific white shrimp

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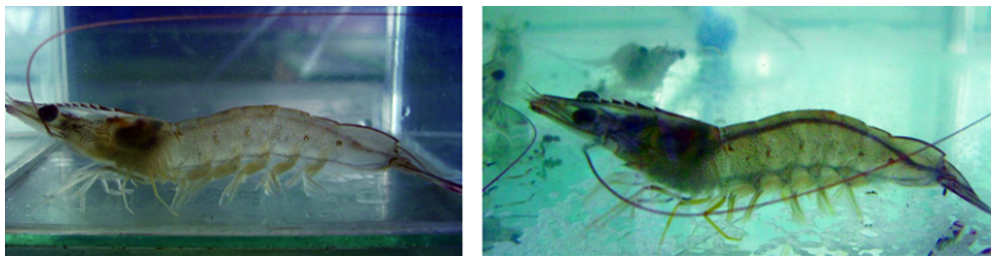
Ideal temperature for the best digestibility of nutrients is 29 to 31 degrees-C



The shrimp on the left has an empty gut before feeding started. The other shrimp's gut is full 20 minutes after feed intake taken at 34 degrees-C.

The rates at which feed is consumed and digested by shrimp vary with the temperature of the culture environment as well as other factors. Laboratory research and subsequent field trials by the authors examined the effects of varied water temperature on the feeding process of Pacific white shrimp, *Litopenaeus vannamei*.

Laboratory experiments

In laboratory experiments carried out at Kasetsart University in Thailand, several empty-gut shrimp with average weights of 12 grams were placed in aquariums filled with filtered seawater for evaluation of feed passage through the intestine at experimental temperatures of 24, 26, 28, 30, 32 and 34 degrees-C, which resemble those of common shrimp culture conditions.

Elapsed times at the following stages were recorded:
• When feed was first observed in the gut
• At half-full gut

• At full gut, before feces were excreted
• Beginning of feces excretion
• Beginning of empty gut
• Fully empty gut.

Feed was applied at 3 percent body weight according to a feed table developed by Kasetsart University. Thus, feed was applied as 1 percent body weight for each of the three daily meals. Leftovers like feces, exuviae and uneaten feed were siphoned before each feed application.

Experimental results

For most treatments, it took only five minutes to initially observe feed in the empty guts after feed ingestion, but significant differences in speed of digestion started to show later. For instance, it took up to 55 minutes at 24 degrees-C versus 20 minutes at 34 degrees-C for the shrimp's guts to become full. Once feces started to be excreted, differences increased even more, as this time went up to 105 minutes at 24 degrees-C versus 35 minutes at 34 degrees-C. Results from all trials are compared in Table 1.

Ching, Ranges of time for stages, Table 1

Shrimp Gut Stage (minutes)	Temperature (° C) 24	Temperature (° C) 26	Temperature (° C) 28	Temperature (° C) 30	Temperature (° C) 32	Temperature (° C) 34
Food observed in gut	15	5	5	5	5	5
Half-full gut	20-30	15-20	15	10-15	10-15	10
Full gut	50-55	25-30	25-30	20-25	20-25	15-20
Start feces excretion	90-105	35-60	35-55	30-45	25-40	20-35
Beginning empty gut	150-165	100-105	95-105	90-100	75-95	75-90
Fully empty gut	225-240	210-220	180-200	180-190	140-150	135-140

Table 1. Ranges of time for stages of feed passage through shrimp intestines at six experimental temperatures under laboratory conditions.

Field trials

Evaluations of feed consumption using feed trays at different temperatures was done at the Golden Sun farm located in Maoming, Guangdong, China, during the summer and autumn cycles of 2010.

Trials were done in eight 0.25-hectare ponds stocked at 150 animals per square meter. Evaluations started when feed consumption increased strongly (at 6-grams average weight and feeding at 3.5 percent body weight) and finished at harvest (14-gram weight, 2.5 percent body weight feeding).

A feed table was used as a reference for feed doses, but feed tray readings were given priority for feed adjustments every day. Only 4 percent of the daily dose was placed in the feed trays, and the rest was broadcasted.

Feed was applied in equal doses to the ponds at 6 a.m., 10 a.m., 3 p.m. and 6 p.m. at different temperatures. Temperature was recorded before each dose, and feed trays were checked one to three hours after feed application. Feed doses were increased to a ceiling of 30 percent above the corresponding levels in the feed table.

Results grouped in three temperature ranges (Table 2) showed that at 32 to 34 degrees-C, leftovers were never found, while at ranges of 26 to 28 degrees-C and 29 to 31 degrees-C, feed consumption was considered in calculating the appropriate feed doses.

Ching, Consumption on feed trays, Table 2

Time (% leftover feed in trays)	Temperature (° C) 26-28	Temperature (° C) 29-31	Temperature (° C) 32-34
After one hour	10-20	2-5	0
After two hours	5-15	0-2	0
After three hours	0-2	0	0

Table 2. Consumption on feed trays at different temperature ranges. Feed doses were calculated from a feed table using complementary information from feed tray readings.

Feeding at high temperatures

During the summer cycle, it was observed that feeding at 32 degrees-C or higher could produce an excess proliferation of phytoplankton, perhaps due to the high amount of nutrients liberated from feed and high accumulation of organic matter on the bottom. Consequently, masses of dead algae accumulated on the surface of the ponds. This situation became dangerous when excess feed increased the presence of toxic compounds like nitrites and the proliferation of *Vibrio* and other pathogenic bacteria, causing mortalities to shrimp.

It is worth mentioning that shrimp in some ponds outside the trial that were fed only 3 times/day had better feed conversion and survival than those in ponds fed 4 times/day, perhaps due to the deletion of the dose at 3 p.m., when temperatures peaked above 32 degrees-C. With less feed applied, culture conditions improved, as well as survival rate.

Perspectives

Nutritionists at Kasetsart University have found that the ideal temperature for the best digestibility of nutrients by shrimp is between 29 and 31 degrees-C, which coincides with the best range for feed conversion observed in these trials. According to the experiments described here, shrimp digestion at temperatures ranging from 24 to 28 degrees-C can take three to four hours, indicating that intervals between each feed dose should be perhaps five to six hours to allow the complete digestion and consumption of feed for each dose.

On the other hand, at temperatures higher than 32 degrees-C, digestion is much faster, and feed consumption may be higher. However, there is danger in increasing feed doses to levels that can bring higher organic matter concentrations on pond bottoms, phytoplankton blooms and large numbers of pathogenic bacteria. Finally, it was noted that by avoiding feeding at temperatures above 32 degrees-C, pond and production conditions were improved.

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