Global Aquaculture Advocate

FEED SUSTAINABILITY (/ADVOCATE/CATEGORY/FEED-SUSTAINABILITY)

Research validates forecast declines in shrimp fishmeal, fish oil requirements

Wednesday, 1 September 2010

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Study evaluates soy protein concentrate, soybean oil

Ingredients used in the production of shrimp diets included (center) commercial feed and (clockwise from bottom center), wheat meal, soybean meal, squid meal, blood meal, meat and bone meal, fishmeal made from fish offal and by-catch, anchovy fishmeal, fish solubles and algae meal.

Traditionally, feeds for marine shrimp have been dependent on the use of fishmeal and fish oil to supply essential nutrients such as protein, amino acids and omega-3 fatty acids for growth and survival. Although other protein and lipid sources derived from plant and land animals are available and widely used in shrimp feeds, none has been able to fully replace the individual value of fishmeal or fish oil. The problem is that increasing levels of these marine ingredients are needed to meet the rapid growth of the aquaculture industry.

A global survey conducted in 2008 by aquaculture nutritionists Albert G. J. Tacon and Marc Metian on the use of fishmeal and fish oil in aquafeed revealed that marine shrimp were the top consumer of fishmeal within the aquaculture sector. However, Tacon and Metian anticipated that commercial shrimp feeds were gradually moving away from the use of fishmeal and fish oil. They predicted the maximum inclusion levels of fishmeal and fish oil in complete diets for penaeid shrimp as follows: 12 and 2 percent in 2010, 8 and 1.5 percent in 2015 and 5 and 1 percent in 2020, respectively.

Experimental design

Challenged by their predictions, the authors carried out a 10-week case study to measure the effects of replacement of anchovy fishmeal and fish oil with soy protein concentrate (SPC) and soybean oil (SBO) on the performance of white shrimp (*Litopenaeus vannamei*) at LABOMAR's aquaculture facilities in Brazil.

SPC is a refined product made from standard soybean meal in which most of the carbohydrate content is removed. As a result, the protein level of SPC is around 65 percent (comparable to fishmeal), lipid levels are lower than 1 percent, and ash content is about 6 percent. Moreover, most of the antinutritional factors found in soybean meal are destroyed during the SPC manufacturing process. Despite its good essential amino acid profile, SPC is still deficient in methionine and can have palatability problems.

In the lab, eight practical isonitrogenous (38 percent crude protein) and isoenergetic (15.9 MJ/kg, dry matter basis) diets were manufactured with two levels of fish oil, 2 percent in the control and 1 percent in test diets. For each group of three diets with the same inclusion level of fish oil, fishmeal was increasingly substituted by SPC at 0 percent (control), 30 percent and 60 percent.

In practical terms, replacement levels meant the use of fishmeal at 12.0, 8.5 and 5.0 percent, respectively, following Tacon and Metian's forecasts. In two additional diets, 100 percent of fishmeal was replaced by SPC. The year "2025" was assigned for these two non-fishmeal diets. As SPC inclusion increased in the formulas, the dietary level of SBO increased in order to balance the lipid and energy content of the diets. Whenever necessary, experimental diets were supplemented with synthetic sources of methionine and lysine (Table 1).

Sa, Experimental diet composition, with two levels of fish oil, Table 1

Feed Composition	Year of Forecast 2010	Year of Forecast 2010	Year of Forecast 2015	Year of Forecast 2015	Year of Forecast 2020	Year of Forecast 2020	Year of Forecast 2025	Year of Forecast 2025
Anchovy fishmeal (%)	12.00	12.00	8.50	8.50	5.00	5.00	0	0

Anchovy fish oil (%)	2.00	1.00	2.00	1.00	2.00	1.00	2.00	1.00
Soy protein concentrate (%)	0	0	3.85	3.84	7.75	7.75	13.34	13.32
Soybean oil (%)	1.05	2.04	1.33	2.30	1.80	2.79	2.51	3.45
Fishmeal substitution (%)	0	0	30	30	60	60	100	100
Fish oil:soybean oil ratio	1.9	0.5	1.5	0.4	1.1	0.4	0.8	0.3

Table 1. Experimental diet composition, with two levels of fish oil: standard 2% and experimental 1%. Fishmeal and fish oil use followed Tacon and Metian's forecasts, except in 2025.

The study was conducted in 50 circular tanks of 500 L each that operated under a continuous water recirculation regime. *L. vannamei* of 2.02 ± 0.51 g were stocked at 70 animals/m^2 (40 shrimp/tank) and fed twice a day according to their appetites.

Results

At harvest, there was no significant difference in shrimp survival among the different feed treatments (P > 0.05). Final shrimp survival ranged from 89.6 to 94.6 percent. On the other hand, there were differences in weekly growth rates and final shrimp body weight among shrimp fed the experimental diets (P < 0.05; Fig. 1). Shrimp growth decreased as fishmeal was replaced by SPC from 0.69 to 0.58 g/week in shrimp fed diets with 2.0 percent fish oil, and from 0.74 to 0.53 g/week in shrimp fed diets with 1 percent fish oil.

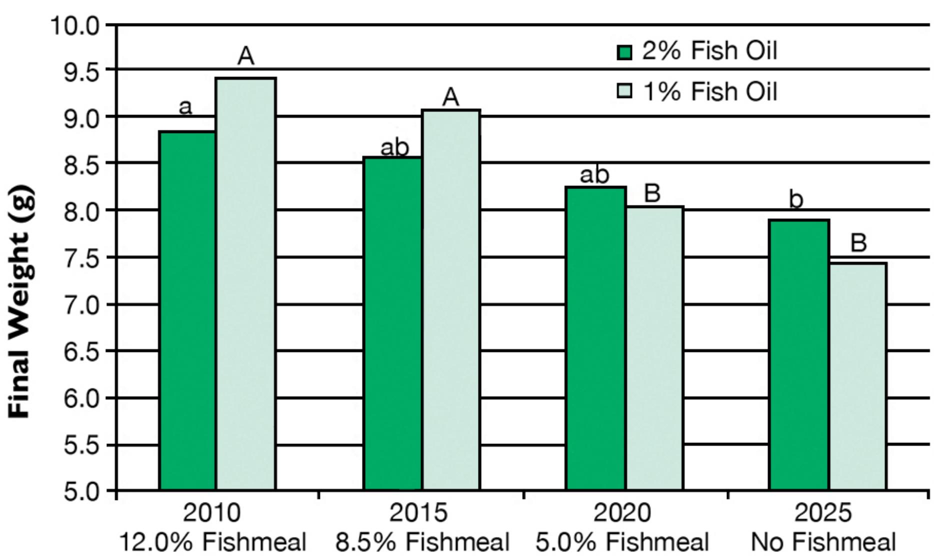

Fig. 1: Final body weight of *L. vannamei* reared in an experimental system. Shrimp were fed diets with progressive replacement of anchovy fishmeal by soy protein concentrate at fish oil inclusion levels of 2 percent (standard) or 1 percent (experimental).

The slowest growth was found for the diets with no fishmeal, regardless of fish oil inclusion. However, there was no difference in shrimp final body weight when diets with 12.0 or 8.5 percent fishmeal were compared at both levels of fish oil use.

Tacon and Metian's forecast of 5 percent inclusion of fishmeal in shrimp feeds was only feasible if fish oil remained at 2 percent inclusion. In addition, the present work showed that the minimum fish oil:soybean oil ratio possible without significant growth decline was 1.1:1. The lowest possible combinations of dietary inclusion were 5 percent fishmeal-2 percent fish oil (diet 2020) and 8.5 percent fishmeal-1 percent fish oil (diet 2015). It remains to be known which is more economically advantageous.

(Editor's Note: This article was originally published in the September/October 2010 print edition of the Global Aquaculture Advocate*.)*

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