Using feed with reduced levels of fish meal for commercial production of the Pacific white shrimp in Asia

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Evaluation of diets with soybean meal as the main plant protein source and poultry by-product meal as the second animal protein source showed that shrimp growth performance was not affected.

The commercial culture of shrimp is one of the most successful sectors of the aquaculture industry. Currently, the Asia-Pacific region accounts for 88% of shrimp and prawn production, with the top five producers China, Thailand, Viet Nam, Indonesia, and India accounting for 81% (FAO 2009a). Production in this region has shifted from indigenous species to mainly the Pacific white shrimp or white leg shrimp *Litopenaeus vannamei*.

This shift has resulted in increased world production of this white shrimp from 145,386 tonnes in 2000 to 2,296,630 tonnes in 2007. The value has increased correspondingly from USD 792,883 to USD 8,815,854 (FAO 2009b). In 2000, Ecuador, Mexico and Brazil accounted for 75% of the world production of the Pacific white shrimp. In 2007, these Latin American countries represented only 14% of world production whereas China, Thailand, Indonesia and Viet Nam accounted for 82% (Table 1). In 2007, 1,065,644 tonnes of Pacific white shrimp were harvested in China, representing 84% of production. Thailand, the second largest producer of *L. vannamei*, produced 490,000 tonnes in 2007 and this represented 98% of their shrimp production. In 2007, Indonesia reported 164,466 tonnes of *L. vannamei* production and 133,113 tonnes of *P. monodon* production, while Viet Nam's production reached 153,000 tonnes of *L. vannamei* and 170,000 tonnes of *P. monodon* (FAO 2009b).

A semi-intensive shrimp farm in Latin America. Latin American farmers typically use significantly lower shrimp stocking density than farmers in the Asia-Pacific region.

Fish meal as a cost-effective feed ingredient

Despite the continued expansion of commercial shrimp farming, the industry faces a number of environmental, social and economic challenges. For instance, the rapid increase in production has exceeded demand, resulting in declines in value. In addition, the worldwide economic crisis has reduced consumption in the main markets, which has reduced industry profitability. There are also other constraints such as the use of fish meal as a cost-effective source of high quality animal protein and essential dietary lipids

It is estimated that in 2003, 22.8% of the fish meal available for aqua feeds was used in shrimp culture, followed by marine fish and salmon with 20.1% and 19.5%, respectively. For a sustainable industry these figures need to be reversed, since fish meal prices are increasingly affecting the cost of feed production. Also, there is substantial pressure from environmental groups to reduce the use of fish meal in aqua feeds because of the negative relationship between what it is consumed and what it is produced. Another concern is that fish meal production is also affecting global fish stocks. This forces producers to look for alternatives to reduce feed cost and ensure a sustainable shrimp culture industry.

Therefore, shrimp nutrition and feed management is emerging as a tool for producers to achieve cost reductions, leading to better profitability and sustainability of operations. Typically, shrimp feeds represents 40% to 70% of variable costs of most farming operations ranging from semi-intensive to intensive systems, either in Asia or Latin America. Thus, replacement of fish meal using other animal protein sources and/or plant proteins, with balanced formulations, may reduce substantially the feed cost of shrimp production.

Table 1. World production of Pacific white shrimp in 2000-2007 in tonnes (Source: FAO, 2009 Fish Stat Plus).

Country	2000	2001	2002	2003	2004	2005	2006	2007
Ecuador	50,110	45,269	63,600	77,400	89,600	118,500	149,200	150,000
Mexico	33,480	48,014	45,853	45,857	62,361	90,008	112,495	113,540
Brazil	25,388	40,000	60,253	90,190	75,904	63,134	65,000	65,000
China	0	87,839	175,286	526,446	638,490	702,484	887,838	1,065,644
Thailand	0	0	60,000	132,365	251,698	374,487	490,000	490,000
Indonesia	0	0	0	0	53,217	103,874	141,649	164,466
Vietnam	0	0	10,000	31,717	40,000	100,000	150,000	153,000
World Production	145,386	267,953	473,449	982,663	1,297,935	1,647,405	2,090,935	2,296,630

Reducing fish meal in shrimp diets

In a recent study, commercial shrimp feeds with different levels of fish meal inclusion and formulated to contain 35% crude protein and 8% lipids were evaluated. Fish meal was reduced gradually from 9% to 0%, using poultry by-product meal as a second animal protein source with a constant inclusion level of 16%, and soybean meal as the main plant protein source (Table 2). The inclusion rate of soybean meal ranged from 32.48% up to 39.52%. Nutritional composition for all the diets was similar.

Table 2. Ingredient composition of practical diets for *L. vannamei* (values expressed on as fed basis, g/100 g) (Amaya et al. 2007).

Ingredient	0% FM	3% FM	6% FM	9% FM
Soybean meal	39.52	37.17	34.82	32.48
Fish meal	0.00	3.00	6.00	9.00
Poultry by-product meal	16.00	16.00	16.00	16.00
Milo (commercial sorghum)	30.68	32.33	33.82	35.47
Corn gluten	4.84	3.17	1.67	0.00
Fish oil	4.72	4.47	4.22	3.96
Di-calcium phosphate	2.65	2.27	1.88	1.50
Bentonite	1.00	1.00	1.00	1.00
Mold inhibitor	0.15	0.15	0.15	0.15
Vitamin premix	0.34	0.34	0.34	0.34
Mineral premix	0.08	0.08	0.08	0.08
Stay-C 35%	0.02	0.02	0.02	0.02

Diets were evaluated under experimental pond conditions in 0.1 ha ponds for 18 weeks, and the production parameters from those diets did not exhibit any significant effect from totally replacing fish meal. Key production parameters had the following average values: final weight 19.6 g, production 6,026 kg/ha, growth rate 1.12 g/week, FCR 1.22, and survival 88.15%. However, total feed input cost was significantly reduced when more plant proteins were included in the diets (Amaya et al., 2007). Another step in this research consisted of replacing the poultry by-product meal with an all plant protein diet. Soybean meal reached 58% in the feed formulation without affecting shrimp growth performance or pond production.

Sampling shrimp at an intensive shrimp farm in China.

Currently, the American Soybean Association International Marketing program is disseminating these results globally. Methodology for this effort includes a series of regional seminars where results of

research are presented. During these seminars, producers and feed manufacturers to replicate this technology were identified. In such field trials, shrimp farmers are asked to compare their traditional feed against a nutritionally balanced feed with higher inclusion rates of soybean meal.

Although controlled conditions on commercial farms can be difficult to maintain, farmers are asked to follow a protocol that includes the use of replicate ponds (three replicates per feed treatment) and shrimp post larvae from the same origin and that will be stocked under similar conditions. Farmers are also encouraged to use their traditional feeding and culture procedures, so there is only one variable to evaluate. Transfer of this technology also includes improving manufacturing practices at the feed mill to achieve better feed quality and lower the cost of feed.

Commercial demonstration feed trials have been performed under semi-intensive conditions in shrimp farms in Ecuador, Mexico and Columbia, with substitution of 50 to75% of the fish meal inclusion. Considering that culture conditions in the Asia-Pacific region are intensive to super-intensive, while in the Americas, culture is extensive to semi-intensive, validation of the technology under Asia-Pacific conditions is important. Preliminary trials under intensive conditions have started in China and the initial results encourage the use of diets with high inclusion rates of soybean meal.

The increasing use of soybean meal and other plant proteins as protein sources in shrimp feeds will allow for some reduction in feed cost. However, we would like to highlight that feeds should not only be nutritionally complete and cost effective but they must also be properly applied to prevent both overfeeding and waste.

References

Amaya, E. A., D. A. Davis, D. B Rouse. 2007. Replacement of fish meal in practical diets for the Pacific white shrimp (*Litopenaeus vannamei*) reared under pond conditions. Aquaculture 262, 393-401.

FAO. 2009a. The State of World Fisheries and Aquaculture 2008. Rome. 176 p, FAO (UN), Rome, Italy.

FAO. 2009b. Fish Stat Plus, Aquaculture production: quantities 1950-2007, Aquaculture production values 1950-2007 Vers. 2.30, FAO (UN), Rome, Italy.

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