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Turbot growth performance on soy-based feeds

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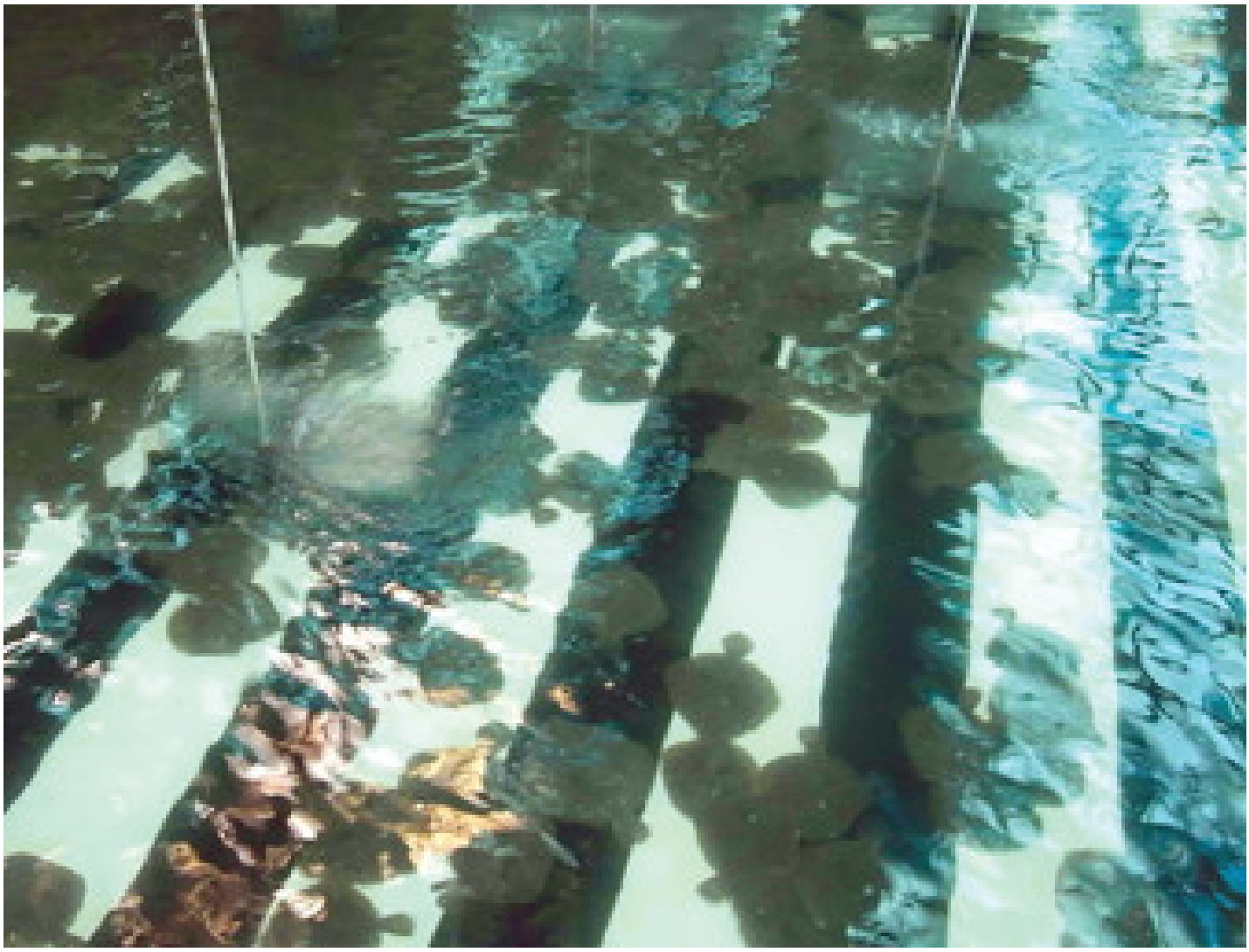
Studies find good feed performance with soy protein concentrate

Turbot (*Scophthalmus maximus*) were introduced to China in 1992 and commercially produced since 1995. The high value of the fish — as high as $60/kg in the late 1990s — led to the rapid development of their aquaculture production. However, the quick growth lacked sustainability. In 2006, chemical residues were found in turbot in the Shanghai fish market. Prices for the fish dropped below $3/kg after the incident, and the industry almost crashed.

The turbot farmers who survived learned a serious lesson from the incident and started paying more attention to production practices. From that point, most turbot farmers have applied biosecurity and shifted from trash fish to manufactured feed for production.

In China, most turbot feeds contain about 50 percent crude protein and 10 percent fat. The industry commonly uses 45 to 60 percent fishmeal in the diets, since turbot are recognized as a highly carnivorous spices. Fishmeal prices increased dramatically in recent years and are expected to be higher in the future. Therefore, economical, high-quality turbot feed is needed for industry sustainability.



Ongoing research is studying optimized least-cost formulations incorporating soy in turbot diets. The stripes on the tank bottom darken the body color of turbot for better market appeal.

Feeding study, 2013

To evaluate the performance of turbot fed diets with high soy content, the authors initiated a feeding demonstration project in 2013 at Yantai Taihua Marine Technology Co., Ltd., located in Yantai, Shandong Province, China. Fish were raised in square, 6- x 6- x 0.5-m concrete tanks with 600 percent daily water exchange. The test diet was formulated to contain 50 percent protein and 10 percent fat, levels similar to those of the existing commercial turbot feeds.

Table 1. Compositions (%) of soy-based diets used for turbot growout.

Ingredient	Soy Maximized Diet (10% Fishmeal)	Soy Optimized Diet (21% Fishmeal)
Soybean meal	0	8.00
Soy protein concentrate	40.00	26.00
Hydrolyzed fish protein	3.00	3.00
Wheat flour	18.70	18.20
Corn gluten meal	6.50	5.50
Blood meal	7.50	7.50
Calcium phosphate	1.44	0.40
Fishmeal (anchovy)	10.00	21.30
Fish oil	4.00	5.60
Soy oil	3.20	1.20
Soy lecithin	1.50	1.00
Vitamin premix	0.50	0.50
Mineral premix	0.25	0.25
D.L.-methionine	0.28	0.18
L-Lysine HCL	0.33	0.13
Taurine (95%)	2.00	0.50
Threonine	0.11	0.05
Choline chloride (50%)	0.04	0.04
Vitamin C (35%)	0.03	0.03

Table 1

The formulation consideration was maximizing soy in the diet with proper nutrition for the turbot. The test diet, which contained 10 percent fishmeal and 40 percent soy protein concentrate (SPC) (Table 1), was fed twice daily. Approximately 1,000 fish were stocked in each of three tanks.

The fish grew from 167.5 to 302.5 g in 124 days, reflecting decent growth. The average feed-conversion ratio (FCR) and survival rate from two of the tanks were 1.02 and 99.8 percent, respectively. The FCR value was similar to that obtained using the commercial feed, according to the farm operator. The results indicated that proper formulation using soy protein concentrate could replace a significant quantity of the fishmeal in turbot diets.

Feeding study, 2014

In a 2014 study, the goal was to evaluate the growth and economic performance of turbot fed a soy-based diet with least-cost formulation. This study was also conducted at Yantai Taihua Marine Technology under the same conditions used in 2013.

Table 2. Growth performance of turbot on three study diets.

	Soy Maximized Diet (10% Fishmeal)	Soy Optimized Diet (21% Fishmeal)	Commercial Diet (50% Fishmeal)
Culture period (days)	124	124	124
Average survival (%)	98.4%	99.0%	98.0%
Fish growth (g)	23.0 to 105.9	20.2 to 112.1	20.3 to 119.4
Specific grow rate (%)	0.53%	0.60%	0.62%
Daily weight gain (g)	0.67	0.74	0.80
Average feed-conversion ratio	0.79	0.78	0.72

Table 2

Fish with average initial weights of about 20 g were stocked at a density of 2,000 fish/tank. Formulated to be 50 percent crude protein and 10 percent fat (Table 1), the optimized test diet contained 21.3 percent fishmeal, 8 percent soybean meal and 26 percent soy protein concentrate. The 2014 study also used the 10 percent fishmeal diet from the 2013 study and a local commercial diet containing 50 percent fishmeal.

Data on fish growth, FCR and economic growth performance are presented in Table 2. The turbot grew from 20 to over 110 g. The average FCRs for the 10, 21 and 50 percent fishmeal diets were 0.79, 0.78 and 0.72, respectively. The feed costs per kilogram of fish weight gain are shown in Table 3.

Table 3. Calculated feed costs per kilogram of fish weight gain.

	Soy Maximized Diet (10% Fishmeal)	Soy Optimized Diet (21% Fishmeal)	Commercial Diet (50% Fishmeal)
Average feed-conversion ratio	0.79	0.78	0.72
Feed cost (U.S. $/kg)	2.00	2.00	2.30
Feed cost/g weight gain (U.S. $)	1.58	1.56	1.66
Difference/kg weight gain (U.S. $)	0.02	0	0.10

Table 3

Although the commercial diet generated the lowest FCR, the feed cost per kilogram of weight gain was highest due to its high fishmeal content. The optimized soy diet that contained about 21 percent fishmeal generated the lowest feed cost per kilogram of weight gain.

Soy diet formulation

The aquafeed industry commonly recognizes that carnivorous species have a limited capability to digest plant protein. Soy contains a nitrogen-free extract (NFE), which is mostly non-starch polysaccharide that is poorly digested by carnivorous species. This limitation needs to be considered in feed formulation. Soybean meal contains 32 percent NFE, and 65 percent protein soy protein concentrate contains 16 percent NFE.

The ratio of animal protein to plant protein was 1:2 in the soy maximized diet and 1:1 in the soy optimized diet. Although the soy diets had different protein sources, the NFE values of the two diets were fairly similar, less than 7 percent. The study results showed no difference in fish growth performance between the diet treatments.

Perspectives

In general, carnivorous fish species have poor tolerance of soy NFE. Chinook salmon, for example, have zero tolerance. However, the tolerance among carnivorous species varies. Table 4 shows the soy NFE tolerance of various fish species.

Using a combination of dehulled soybean meal and soy protein concentrate can effectively replace fishmeal and lower the cost of feed while achieving adequate performance in fish growth and economy. A current study is evaluating the optimized soy diet when fed to 250-g submarket-size fish grown to a market size greater than 600 g.

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