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Tilapia LVHD Cage Production with 24%, 28%, 32% and 36% Protein Soy-Based Feeds

Results of ASA-IM China 2010 Feeding Demon U-35-10-512

Zhou Enhua, Zhang Jian, Michael C. Cremer and Timothy O'Keefe

American Soybean Association - International Marketing
Room 1016, China World Tower 1
No. 1 Jianguomenwai Avenue
Beijing 100004, P.R. China

INTRODUCTION

A tilapia feeding demonstration was jointly conducted in 2010 by the American Soybean Association International Marketing (ASA-IM) and the Hainan Fish Breeding Farm of the Beijing Municipal Fishery Extension Center, Haikou City, Hainan Province. The objective of the demonstration was to demonstrate the optimal feed protein level for maximizing economic return for tilapia cultured in low volume, high density (LVHD) cages. The demonstration compared tilapia growth and production cost with feeds varying in protein level from 24% to 36%. Optimizing feed protein level is critical to maximizing economic return in tilapia operations, where the current economic environment and increasing competition have narrowed profit opportunities.

PROTOCOLS

The 2010 tilapia LVHD cage feeding demonstration was conducted in Baitang Reservoir near Haikou, Hainan Province, China under jurisdiction of the Hainan Fish Breeding Center of the Beijing Municipal Fishery Extension Center. Twelve, 4-m^3 LVHD cages

were used for the comparison study, with three cages being assigned to each of four test feeds. The cages were outfitted with opaque covers to reduce light and external motion stress. A feed enclosure approximately 1-m square in size was installed inside each cage. The feed enclosure extended sufficiently above and below the water line to contain extruded, floating feed pellets. The cages were tied along surface rope bridles in rows, with a distance of 2 m between cages within the same row, to allow sufficient water exchange, and a minimum distance of 50 m between cage rows.

The twelve demonstration cages were stocked on 25 June 2010 with all-male, GIFT strain tilapia produced locally. Tilapia averaged 50 g in weight at the time of stocking. The tilapia fingerlings were stocked at a density of 300 fish/m3 (1,200 fish per cage). Target harvest size was 500 g per fish, and tilapia in the three replicate cages for each of the four feed treatments were to be harvested when the average fish size for that feed treatment reached 500 g.

Tilapia in the twelve cages were fed one of four test feeds for the duration of the demonstration. The four feeds differed in crude protein level but had the same digestible energy to digestible protein (DE:DP) ratio (Table 1). The four feed crude protein levels were 24%, 28%, 32% and 36%, with corresponding lipid levels of 3.5%, 4.0%, 6.0% and 7.0%, respectively. The DE:DP ratio was constant for the four feeds at 8.4 kcal of energy per gram of protein. The 32% protein and 6% lipid diet was the ASA-IM standard growout feed for tilapia and served as the control for purposes of determining whether the tilapia exhibited typical production performance in the demonstration. All feeds were produced by Ningbo Techbank Feed Company, Zhejiang Province using ASA-IM formulations and under ASA-IM technical guidance. All feeds were least-cost formulated from available ingredients.

Each of the four protein level feeds was fed to tilapia in three cages as treatment replicates. All test feeds were fed in extruded, floating pellet form. Feed pellet size was increased appropriately as the tilapia grew, with pellet size maintained at approximately one-half the full open mouth size of the fish. Fish in all cages were fed twice daily using the ASA-IM 90% satiation feeding technique. Feedings were at approximately 8:00 a.m. and 4:00 p.m. daily. Fish in the three replicate cages of each feed treatment received an identical amount of feed each day and at each feeding, but the 90% satiation feed amount was adjusted separately for each feed treatment. Daily feed records for each cage were kept by the cooperator. Daily feed amounts were added together and recorded in the ASA-IM Demonstration Data Book for each respective sampling period and for each feed treatment.

The four test feeds were analyzed at the Feed Research Institute of Chinese Academy of Agricultural Sciences, Beijing. Dry matter was analyzed by drying the samples to constant weight at 105℃. Crude protein was determined by digestion using the Kjeldahl method (AOAC 1997) and crude protein content estimated by multiplying nitrogen by 6.25. Crude lipid was measured by acid hydrolysis with a Sotex System Hotplate 2022 Hydrolyzing Unit (Foss, Hillerød, Denmark), followed by Soxhlet extraction using a

Sotex system 2050 (Foss, Hillerød, Denmark). Gross energy was determined by Parr 1281 Automatic Bomb Calorimeter (Parr, Moline, IL, USA).

RESULTS

The number of culture days for tilapia to grow from 50 g to the targeted 500 g market size was inversely proportional to the protein level of the feed, with the shortest time to market of approximately 110 days obtained with the 36% and 32% protein feeds, and the longest time to market of approximately 150 days obtained with the lowest protein feed (24%) (Table 2, Figure 1).

Highest and lowest daily weight gains for tilapia were obtained with the 36% and 24% protein feeds, respectively. The feed conversion ratio (FCR) was also inversely related to the protein level of the feed, with the lowest FCR of 1.25:1 obtained with the highest protein feed (36%), and the highest FCR of 1.74:1 obtained with the lowest protein feed (24%) (Table 2).

The protein retention ration (PRR) was inversely proportional to the protein level among the four test feeds. The 24% protein feed had the highest protein retention ration, followed by the 28% and 32% protein feeds. The 36% protein feed had the lowest protein retention ration (Table 3) because it was over formulated for tilapia and some were deposited as fat.

The lowest feed cost per unit of fish gain, the highest net economic return, and the highest return on investment (ROI) were all obtained with the 32% protein feed (Table 4). Feed cost per unit of fish gain was RMB 7.07 for the 32% protein feed, in comparison to RMB 7.30, RMB 7.08 and RMB 7.22 for the 36%, 28% and 24% protein feeds, respectively. The 32% protein feed had an average price of RMB 5.05/kg ($0.68/kg), and was 13.7% less expensive than the 36% feed, and 10% and 17.8% more expensive than the 28% and 24% protein feeds, respectively.

Net income with the 32% protein feed was 3.85 times and 2.67 times greater than with the 24% and 28% protein feeds, respectively. There was less than a 2% difference in net income between the 32% and 36% protein feeds. Return on investment (ROI) was highest (20.2%) with the 32% protein feed, and lowest with the 24% protein feed. ROI was less than 7% and 5% with the 28% and 24% protein feeds, respectively.

SUMMARY AND CONCLUSIONS

Results of the demonstration indicate that formulating feed to optimize protein can yield significant production, economic and risk advantages for tilapia farmers. A feed protein level of 32% was found to yield the lowest feed cost per unit of fish gain and the highest net economic return and return on investment ROI. Tilapia stocked at 50 g obtained a

target market size of 510 g with the 32% protein feed in approximately 110 days, 40 days less than with the 24% protein feed, which significantly shortened the time to market and therefore production risk over the lower protein diets tested.

The FCR of 1.41:1 with the 32% protein feed was higher than that normally obtained with this feed because some fish escaped during a 50-year storm even that impacted the reservoir site. The higher FCR with the 28% and 24% protein feeds resulted in an approximately 20% higher waste input into the water system than with the 32% protein feed. As a result, the low protein feeds increased risk by increasing the potential for disease, water quality and other factors to impact the fish crop in response to the higher waste input.

Global tilapia farmers are encouraged to use a nutritionally balanced, 32% protein, soymeal-based feed to culture tilapia as a means to maximize economic return and improve sustainability through reduced environmental impact.

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Chinese Currency and Production Unit Conversions:

RMB 6.50 = US$1.00
15 mu = 1.0 hectare (ha)
kg/mu x 15 = kg/ha
1.0 kg = 2.2 lb
6 mu = 1.0 acre (ac)
kg/mu x 13.2 = lb/ac

Table 1. Feed formulations for the four protein level feeds compared in the 2010 ASA-IM LVHD cage demonstration with tilapia. DE:DP ratio for all four feeds was constant at 8.4 kcal of energy per gram of protein. The feeds were least-cost formulated by ASA-IM and based on available ingredients in China.

Ingredient	24%	28%	32%	36%
Soybean Meal 46%	*25.50*	*33.00*	*43.00*	*44.2*
Wheat Middlings 16%	*28.00*	*35.00*	*31.30*	*14.00*
Soybean hulls (low-fat)	*30.00*	*11.90*	-----	-----
Fishmeal, Anchovy 64/9	*1.00*	*2.00*	*2.50*	*5.00*
Wheat, Feed Flour 13.2%	*6.00*	*8.00*	*10.00*	*16.50*
Corn Gluten Meal 61%	3.00	3.00	4.00	6.00
Blood Meal spr. 90/0.5	2.00	2.00	2.00	5.00
Fish Oil, anchovy	0.75	0.60	1.00	1.00
Soy Oil	-----	-----	1.80	4.50
Soy Lecithin	0.50	1.50	1.50	1.00
Ca Phosphate Mono 21%	2.21	1.94	1.92	1.83
Vit PMX F-2	0.50	0.50	0.50	0.50
Min PMX F-1	0.25	0.25	0.25	0.25
Choline Chloride 50%	0.10	0.10	0.03	0.03
DL Methionine 99%	0.12	0.14	0.13	0.12
Stay C 35%	0.03	0.03	0.03	0.03
Antioxidant	0.02	0.02	0.02	0.02
Mold Inhibitor	0.01	0.01	0.01	0.01
Mycotoxin binder	0.01	0.01	0.01	0.01
TOTAL	100.00	100.00	100.00	100.00

Table 2. Production results for tilapia cultured with four different protein level feeds in 4-m^3 LVHD cages in Baitang Reservoir, Haikou, Hainan Province, China .

Feed treatment	Harvest wt (g)	No. culture days[1]	FCR[2]	Survival (%)
24% protein	511 g	150	1.74:1	94.7
28% protein	511 g	127	1.55:1	90.8
32% protein	512 g	110	1.41:1	85.43
36% protein	521 g	110	1.25:1	93.6

[1]Tilapia were cultured to larger than 500 g. Number of culture days to 500 g was determined for each feed treatment from sampling data and calculated growth curves.

[2]FCR was calculated from actual feed fed during the number of culture days to fish size 500 g.

[3]The survival of tilapia with the 32% protein feed was lower than the average because some fish escaped during the heaviest typhoon and storm in the past 50 years in Hainan.

Table 3. Protein retention ration in tilapia fed four different protein level feeds in 4-m3 LVHD cages in Baitang Reservoir, Haikou, Hainan Province, China.

Feed Treatment	Protein retention ration (%)
24% protein	42.97
28% protein	40.85
32% protein	37.80
36% protein	37.21

Table 4. Economic parameters for the four protein level feeds fed to tilapia in the 2010 comparison feed demonstration conducted in Haikou, Hainan Province, China.

Parameter	36% Protein	32% Protein	28% Protein	24% Protein
Feed cost/kg (RMB)	5.85	5.05	4.55	4.15
Feed cost per kg of fish gain (RMB)	7.30	7.07	7.05	7.22
Net income/cage (RMB)[1]	956	972	363.6	252
ROI (%)[2]	17.5	20.2	7.0	4.6

[1]Net income per cage is an average of the three replicate cages for each feed treatment

[2]ROI is an average of the three replicate cages for each feed treatment.

Figure 1. Growth curves for GIFT tilapia fed the ASA-IM formulated, extruded and soy-based feed with protein levels of 24%, 28%, 32% and 36% in 4-m3 LVHD cages at Baitang Reservoir, Haikou, Hainan Province, China. Tilapia fed the ASA-IM 24% protein feed grew from 50 g to 511 g with an average FCR of 1.74:1 in 150 days; while the tilapia fed the ASA-IM 28% protein feed grew from 50 g to 511 g with an average FCR of 1.55:1 in 127 days; the tilapia fed the ASA-IM 32% protein feed grew from 50 g to 512 g with an average FCR of 1.41:1 in 110 days; the tilapia fed the ASA-IM 36% protein feed grew from 50 g to 521 g with an average FCR of 1.25:1 in 110 days.