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Soy Protein Concentrate as a Replacement for Fishmeal in the Fingerling Diet for Grass Carp

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INTRODUCTION

Feeding trials in outdoor fish production ponds were conducted in 2008 by the American Soybean Association International Marketing (ASA-IM) program in cooperation with the Heilongjiang Provincial Fishery Extension Center and Shenyang Municipal Fishery Research Institute to show the feasibility of replacing fishmeal with soy protein concentrate (SPC) in the ASA-IM 36/7¹ fingerling feed for grass carp. The trials were conducted to demonstrate to fish farmers and feed millers in the northeastern region of China that an all-plant protein fingerling feed could be used to culture grass carp fingerlings. The ability to use all-plant protein feeds at the fingerling stage provides feed millers with an option to reduce feed cost associated with the rising price of fishmeal, as well as a means to improve industry sustainability by providing a fingerling feed in which the majority of protein is supplied from renewable plant sources.

2008 HARBIN FEEDING TRIAL

Trial Protocols

A three-month feeding trial was conducted near Harbin at the demonstration fish farm of the Heilongjiang Provincial Fishery Extension Center. Grass carp fry of size 0.17-g were stocked in three 5.0-mu (0.33 ha) ponds at a density of 4,000 fish per mu (60,000/ha), together with 1,000 silver carp fry per mu (15,000/ha). Grass carp in the three demonstration ponds were fed the ASA-IM 41/11 crumble fry feed from stocking size to an average fish size of 2-3 g, at which time the fish were weaned to the 36/7 SPC diet. The 36/7 diet was formulated by ASA-IM and replaced the standard 20% fishmeal inclusion with low antigen, feed grade SPC having a crude protein content of 65% (Tables 1 and 2). The feed grade SPC was produced by ADM in China under the trade name Soycomil.

¹The numerical component of the feed description refers to the percentage of protein and fat, respectively, in the ration, i.e. 36/7 indicates 36% crude protein and 7% crude fat.

The 36/7 SPC feed was fed in extruded, floating pellet form, with an initial feed pellet size of 1.5-mm. Grass carp in all ponds were fed to satiation three times daily for the first month, and to satiation twice daily using the ASA-IM 90% average satiation feeding technique. Fish in the three replicate demonstration ponds received an identical amount of feed each day and at each feeding. All feeds were produced by the Ningbo Techbank Feed Company in China. Pond management was based on the ASA-IM 80:20 model.

Trial Results

Grass carp in the Harbin trial were fed for 82 days between 3 July and 23 September 2008. Grass carp grew from 0.17 g to an average weight of 150.4 g, with an average FCR with the 36/7 SPC feed of 0.98:1 (Table 3). Fish biomass at harvest averaged 476 kg/mu (7,140 kg/ha) for grass carp. An additional 50 kg/mu (750 kg/ha) of silver carp were produced on average in the three demonstration ponds. The average survival rates for grass carp and silver carp were 79.1% and 64%, respectively.

The trial yielded a net economic return of RMB 35,145 (\$5,246)² from the 15 mu of ponds, and represented an average net return of RMB 2,343 per mu (\$5,246/ha). Harvested fish had average market prices of RMB 12/kg (\$1.79/g) for grass carp and RMB 4/kg (\$0.60/kg) for silver carp. The average return on investment (ROI) for the three ponds was 65.6%. Feed represented 69.4% of production costs.

2008 SHENYANG FEEDING TRIAL

Trial Protocols

A three-month feeding trial was conducted near Shenyang at the experimental fish farm of the Shenyang Municipal Fishery Research Institute. Grass carp fry of size 0.1-g were stocked in three 2.4-mu (0.16 ha) ponds at a density of 6,000 fish per mu (90,000/ha), together with 750 silver carp fry per mu (11,250/ha). Grass carp in the three demonstration ponds were fed the ASA-IM 41/11 crumble fry feed from the time of stocking to size 2-3 g, at which time the fish were weaned to the 36/7 SPC diet. The 36/7 diet was formulated by ASA-IM and replaced the standard 20% fishmeal inclusion with low antigen, feed grade SPC having a crude protein content of 65% (Tables 1 and 2). The feed grade SPC was produced by ADM in China under the trade name Soycomil.

The 36/7 SPC feed was fed in extruded, floating pellet form, with an initial feed pellet size of 1.5-mm. Grass carp in all ponds were fed to satiation three times daily for the first month, and to satiation twice daily using the ASA-IM 90% average satiation feeding technique. Fish in the three replicate demonstration ponds received an identical amount of feed each day and at each feeding. All feeds were produced by the Ningbo Techbank Feed Company in China using least-cost formulations provided by ASA-IM. Pond management was based on the ASA-IM 80:20 model.

² U.S. dollar values are based on an exchange rate of RMB 6.7 = US\$ 1.00

Trial Results

Grass carp were fed for 91 days between 8 July and 10 October 2008. Grass carp grew from 0.1 g to an average weight of 47.5 g, with an average FCR of 1.26:1 (Table 4). Fish biomass at harvest averaged 225 kg/mu (3,375 kg/ha) for grass carp fed the 36/7 SPC feed. An additional 36 kg/mu (537 kg/ha) of silver carp were produced on average in the three demonstration ponds. The average survival rates for grass carp and silver carp were 79% and 86%, respectively.

The trial yielded a net economic return of RMB 6,178 (\$922) from the 7.2 mu of ponds, with an average return of RMB 858 per mu (\$1,921/ha). Harvested fish had average market prices of RMB 11/kg (\$1.64/kg) for grass carp and RMB 3/kg (\$0.45/kg) for silver carp. The average return on investment (ROI) for the three ponds was 49.7%. Feed represented 72.2% of production costs.

SUMMARY AND CONCLUSIONS

The two demonstration trials effectively demonstrated that grass carp fingerlings do not have a requirement for fishmeal in their diet and that an all-plant protein feed, in which fishmeal is replaced with SPC, can be used to efficiently and economically produce grass carp fingerlings in ponds in northeastern China. Both trials yielded a high economic return despite record high prices for feed in 2008. Feed costs represented an average of nearly 71% of total production costs for the two trials. The high feed prices reflected significant increases in feed ingredient costs globally in 2008.

The Harbin trial yielded more than twice the grass carp production as the Shenyang trial. The smaller size of the fish in the Shenyang trial was reported to be due to a combination of the small fish stocking size of 0.1 g and stress from aquatic birds and unfavorable weather conditions. Fish survival rate was not a factor, as it averaged 79% in both the Harbin and Shenyang trials. A comparison of monthly pond water temperatures indicated the water temperature averaged only 1°C lower in July and August at the Shenyang site than at the Harbin site, and that water temperature was 6°C higher at the Shenyang site in September than at the Harbin site. In addition, fish in the Shenyang trial were fed longer (91 days) than in the Harbin trial (82 days). The 9-day longer growing period and higher September water temperature for the Shenyang site should have resulted in the production of fish similar in size to the Harbin fish. Reduced feeding in response to stress from aquatic birds may have been the primary factor in the slower fish growth in the Shenyang trial.

Feed mills are encouraged to incorporate low antigen, feed grade SPC 65% in their fingerling feed formulations when it is cost effective to do so. Use of SPC as a fishmeal replacement in the fingerling diet of freshwater fish species cultured in China can reduce demand on the limited supply of fishmeal, help stabilize feed prices, and provide feed millers and fish producers with a renewable plant protein option to fishmeal that will better ensure industry sustainability.

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Table 1. Formula comparison for the ASA-IM 36/7 fishmeal feed (36/7 FM) with 20% fishmeal and the ASA-IM 36/7 SPC fingerling feed (36/7 SPC). The 36/7 SPC feed was demonstrated in the 2008 ASA-IM grass carp fingerling pond feeding trials in Harbin and Shenyang, China. The 36/7 SPC feed is formulated to replace fishmeal with low antigen, animal grade SPC. Figures are expressed as a percentage of the as fed diet.

Ingredient	<u>36/7 FM</u>	<u>36/7 SPC</u>
Soybean Meal 46.5%	42.60	22.50
Wheat Middlings 16.5%	-----	16.40
Fishmeal, Anchovy 64.5%	20.00	-----
Soy Protein Concentrate 65% cn	-----	20.00
Wheat, Feed Flour 11.5%	30.00	20.00
Corn Gluten Meal 60%	-----	5.00
Blood Meal spr. 90/0.5	-----	5.00
Fish Oil, anchovy	1.00	2.70
Soy Oil	2.40	2.00
Soy Lecithin/Corn Blend	2.00	2.00
Ca Phosphate Mono 21%	1.10	3.05
Vit PMX F-2	0.50	0.50
Min PMX F-1	0.25	0.25
Choline Chloride 50%	-----	0.24
MHA (methionine) 84%	-----	0.21
Mold Inhibitor	0.10	0.10
Stay C 35%	0.03	0.03
Ethoxyquin, SQ Mixture 6	0.02	0.02
TOTAL	100.00	100.00

Table 2. Calculated nutritional profiles of the ASA-IM 36/7 FM and 36/7 SPC fingerling diets tested in the 2008 grass pond feeding trials in Harbin and Shenyang, China.

Nutrient	Value, As Fed	
	36/7 FM	36/7 SPC
DE Fish (extruded)	2959	2943
NFE	35.35	35.85
Starch	22.61	22.56
Protein, crude	36.26	36.41
Protein, digestible	33.98	34.49
Fish Protein	12.90	0.00
Soy Protein	19.81	23.46
Fat	7.08	7.01
W-3 (omega 3 fatty acid)	1.16	1.10
W-6 (omega 6 fatty acid)	2.04	2.15
Fiber	2.38	3.29
Ash	7.28	6.93
Calcium	1.10	0.69
Phosphorus, available	0.70	0.76
Choline	2560	2489
Vitamin C	105	105
Ethoxyquin	135	135
Arginine	2.29	2.28
Lysine	2.37	2.14
Methionine	0.70	0.71
Methionine + Cystine	1.20	1.24
Threonine	1.46	1.44
Tryptophan	0.44	0.42

Table 3. Results of the 2008 aquaculture feeding trial in Harbin that demonstrated grass carp fingerling production in ponds with an all-plant protein ASA-IM 36/7 fingerling feed in which fishmeal was replaced with soy protein concentrate.

Feed treatment	GrC ¹ stocking size (g)	Stocking rate (fish/mu)	No. days fed	Harvest wt. (g)		P _G ³ (kg/mu)		Survival (%)		FCR	Net economic return (RMB/mu)	ROI (%)
				GrC	SiC ²	GrC	SiC	GrC	SiC			
36/7 SPC	0.17	4,000	82	152	79	485	49	79.7	63	0.97	2,442	68.3
36/7 SPC	0.17	4,000	82	148	76	464	52	78.6	68	1.01	2,200	61.5
36/7 SPC	0.17	4,000	82	151	82	480	50	79.3	61	0.97	2,387	66.8
Mean	0.17	4,000	82	150	79	476	50	79.1	64	0.98	2,343	65.6

¹GrC = Grass Carp

²SiC = Silver Carp

³P_G = Gross Production

Table 4. Results of the 2008 aquaculture feeding trial in Shenyang that demonstrated grass carp fingerling production in ponds with an all-plant protein ASA-IM 36/7 fingerling feed in which fishmeal was replaced with soy protein concentrate.

Feed treatment	GrC ¹ stocking size (g)	Stocking rate (fish/mu)	No. days fed	Harvest wt. (g)		P _G ³ (kg/mu)		Survival (%)		FCR	Net economic return (RMB/mu)	ROI (%)
				GrC	SiC ²	GrC	SiC	GrC	SiC			
36/7 SPC	0.1	6,000	91	40.6	60	198	38	81.3	85	1.40	568	32.9
36/7 SPC	0.1	6,000	91	43.6	55	201	36	76.8	87	1.38	595	34.5
36/7 SPC	0.1	6,000	91	58.2	52	276	33	79.0	86	1.01	1,411	81.8
Mean	0.1	6,000	91	47.5	56	225	36	79.0	86	1.26	858	49.7

¹GrC = Grass Carp

²SiC = Silver Carp

³P_G = Gross Production