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

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INTRODUCTION

A feeding trial was conducted in 2008 by the American Soybean Association International Marketing (ASA-IM) program in cooperation with the Beijing Municipal Fishery Extension Center to demonstrate the feasibility of replacing fishmeal with soy protein concentrate (SPC) in the ASA-IM 36/7¹ fingerling feed for tilapia. The trial was conducted to demonstrate to fish farmers and feed millers in southern China that an all-plant protein fingerling feed would yield equivalent tilapia production and performance as a high fishmeal inclusion feed. The ability to use all-plant protein feeds at the fingerling stage provides feed millers with an option to formulate without fishmeal, which is limited in availability, 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.

TRIAL PROTOCOLS

The tilapia pond feeding trial was conducted at the Hainan Fish Breeding Center of the Beijing Municipal Fishery Extension Center at Wenchang, near Haikou, Hainan Province, China. Monosex, GIFT strain tilapia fry of size 0.5-g were stocked in three 2.0-mu (0.13 ha) and three 2.5-mu (0.17 ha) ponds in early July at a density of 5,000 fish per mu (75,000/ha). Tilapia in the six demonstration ponds were fed the ASA-IM 41/11 crumble fry feed from stocking size to an average fish size of 3 g, at which time the fish were weaned to one of two 36/7 fingerling diets. Tilapia in three of the trial ponds were fed the ASA-IM 36/7 FM feed formulated with 20% fishmeal inclusion, while tilapia in the other three trial ponds were fed the ASA-IM 36/7 SPC feed (Table 1). The 36/7 SPC feed was formulated to replace the standard 20% fishmeal with low antigen, animal grade SPC having a crude protein content of 65%. The animal grade SPC was produced by

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.

Archer Daniels Midland Company (ADM) in China under the trade name Soycomil. The 36/7 FM and 36/7 SPC feeds were formulated to be nutritionally equivalent (Table 2).

Both the 36/7 FM and 36/7 SPC feeds were fed in extruded, floating pellet form, with an initial feed pellet size of 1.5-mm. Tilapia 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 ponds of each feed treatment received an identical amount of feed each day and at each feeding. All feeds were produced by the Ningbo Techbank Feed Company, Zhejiang Province, China using ASA-IM feed formulations and with ASA-IM technical guidance.

TRIAL RESULTS

Tilapia in the Haikou trial were fed for 67 days between 10 July and 15 September 2008. Tilapia fed the 36/7 FM feed grew from 0.5 g to an average weight of 97.5 g, while tilapia fed the 36/7 SPC feed grew from 0.5 g to an average weight of 99.1 g (Table 3, Figure 1). Average FCR with the two feeds was 0.98:1 with the 36/7 FM feed and 0.99:1 with the 36/7 SPC feed (Table 3). There were no differences in fish growth or FCR with the two feeds.

Fish biomass at harvest averaged 435 kg/mu (6,525 kg/ha) with the 36/7 FM feed and 456 kg/mu (6,840 kg/ha) with the 36/7 SPC feed. The higher biomass production with the 36/7 SPC feed was the result of a higher fish survival rate in the 36/7 SPC ponds. Average fish survival in the three 36/7 SPC ponds was 92%, compared to 89% in the 36/7 FM feed ponds.

CONCLUSIONS

The comparison trial demonstrated that tilapia have no requirement for fishmeal during the fingerling production phase, and that a properly formulated all-plant protein diet, in which SPC is used to replace fishmeal, can be used to efficiently and quickly produce 100-g tilapia fingerlings in ponds in southern China. Tilapia growth from 0.5 g to approximately 100 g required only 67 days at water temperatures of 30-32 °C.

Tilapia were shown to have a high tolerance for soy. The trial demonstrated that feed manufacturers can substitute low antigen, animal grade SPC 65% for fishmeal in their tilapia fingerling feed formulation 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) and the ASA-IM 36/7 SPC fingerling feed (36/7 SPC). Tilapia performance with the 36/7 FM and 36/7 SPC feeds was compared in the 2008 ASA-IM tilapia fingerling pond feeding trial in Haikou, Hainan Province, 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 tilapia pond feeding trial conducted near Haikou, Hainan Province, 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 acids)	1.16	1.10
W-6 (omega 6 fatty acids)	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

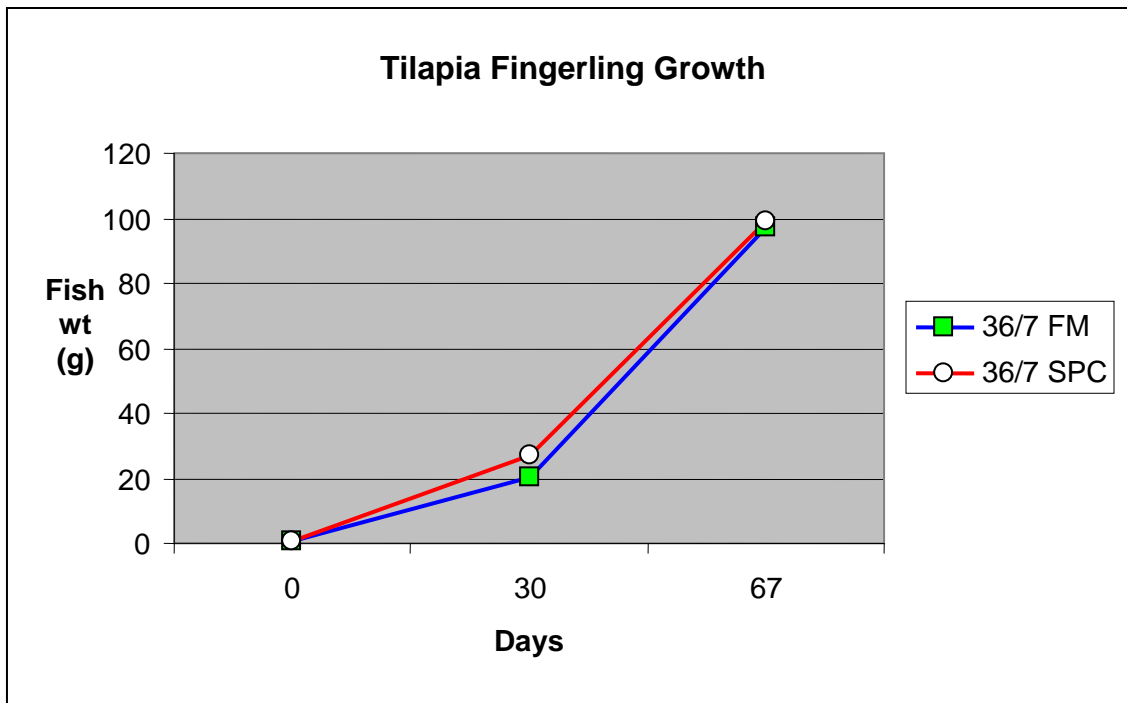


Figure 1. Growth curve for tilapia fingerlings fed 36/7 FM and 36/7 SPC feeds. The 36/7 FM feed contained 20% fishmeal, while the 36/7 SPC feed replaced all fishmeal with low antigen soy protein concentrate (SPC). Tilapia grew from 0.5 g to approximately 100 g in 67 days on both feeds.

Table 3. Results of the 2008 aquaculture feeding trial in Haikou, China that compared tilapia fingerling production in ponds with 36/7 fishmeal (36/7 FM) and 36/7 soy protein concentrate (36/7 SPC) feeds. A 20% fishmeal inclusion in the 36/7 FM feed was replaced with low antigen, animal grade soy protein concentrate in the 36/7 SPC feed.

Feed treatment	NiT ¹ stocking size (g)	Stocking rate (fish/mu)	No. days fed	Harvest weight (g)	P _G ² (kg/mu)	Survival (%)	FCR
36/7 SPC	0.5	5,000	67	100.0	465	93	0.97
36/7 SPC	0.5	5,000	67	98.3	452	92	1.00
36/7 SPC	0.5	5,000	67	99.0	451	91	1.00
Mean	0.5	5,000	67	99.1	456	92	0.99
36/7 FM	0.5	5,000	67	97.0	432	89	0.99
36/7 FM	0.5	5,000	67	96.0	437	91	0.98
36/7 FM	0.5	5,000	67	99.5	437	88	0.97
Mean	0.5	5,000	67	97.5	435	89	0.98

¹NiT = Tilapia

²P_G = Gross Production