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EFFECTS OF ADDITION OF FISH MEAL TO ALL-PLANT FEEDS ON THE DIETARY PROTEIN NEEDS OF CHANNEL CATFISH IN PONDS

by

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ABSTRACT

Channel catfish were stocked in 27, 1/10-acre ponds at the rate of 3,000 per acre and fed nine commercial-type rations containing three protein percentages and three levels of fish meal for 200 days.

Average survival for the experiment was 96.8% and 93% of the fish were over 12 inches in length at harvest. Average yield for treatments ranged from 2,330 to 3,030 lb/acre and the average for all treatments was 2,638 lb.

The results indicated that satisfactory production can be obtained with all-plant rations. The 29%, all-plant protein diet yielded 2,330 lb/acre of harvestable size fish. Increasing total protein in the all-plant rations to 36 and 43% resulted in production of 2,475 and 2,640 lb/acre, respectively.

Replacing 1/6 of the plant protein with fish meal protein, at the 29 per cent protein level, increased production by 100 lb/acre, however, replacing 1/3 of plant protein with fish meal protein yielded an increase of 430 lb.

At the 36 and 43% protein levels, 1/6 fish meal protein significantly ($P < .05$) increased weight gains over the all-plant protein rations, however, a further increase to 1/3 fish meal protein did not significantly increase fish yield.

Under these management conditions and current feed ingredient costs, the extra yields obtained by increasing protein level and replacing plant protein with fish meal protein were profitable, particularly in the 36 or 43% protein diets in which 1/6 of the protein was fish meal.

INTRODUCTION

Protein has always been more expensive than energy in practical catfish feeds, however, since 1973 the cost of protein supplements, especially those of animal origin, have increased dramatically. In order to make more economical use of protein in catfish feeding, which would effect significant reduction in total feed cost, additional information is needed on protein requirements of pond cultured catfish. Several factors profoundly influence the optimum amount of protein in catfish feeds for growth; namely, availability of protein from natural pond organisms, amount of nonprotein energy in the diet, daily feeding rate, water temperature, and protein quality (Lovell, 1969; Dupree, 1967, 1970, Hastings, 1974; Prather and Lovell, 1971, 1973). Of these, protein quality has been least investigated. Better understanding of interrelationships between amount of animal protein and levels of total protein in pond-fed catfish feeds would permit more economical feeds to be formulated inasmuch as animal protein is more expensive than plant protein.

Studies were conducted at the Auburn University Fisheries Research Unit in 1973 to evaluated all-plant diets, diets containing low levels of animal protein (fish meal), and diets with moderate amounts of animal protein, each fed at low (29%), medium (36%), and high (43%) percentages of total protein to channel catfish in earthen ponds.

MATERIALS AND METHODS

A feeding experiment was designed to measure the effects on growth, uniformity of size, dressing percentage, and body composition of thee levels of dietary protein, each fed in either an all-plant diet, a diet containing only 1/6 fishmeal protein, or a diet containing 1/3 fishmeal protein. A total of nine experimental feeds were formulated (Table 1) and processed into 3/16-inch diameter pellets. The all-plant diets (1, 2, and 3) were formulated to meet the amino acid and all other known nutrient requirements for catfish.

Twenty-seven, 1/10-acre earthen ponds were each stocked with 300, 4 to 5-inch channel catfish fingerlings (rate of 3,000/acre). Adjustment feeding of a control ration began soon after stocking on March 15. On April 19, the experimental diets were randomly assigned to the 27 ponds so that three ponds received each diet. The fish were fed once daily, six days per week according to the schedule shown below. Feed allowances were adjusted biweekly based upon monthly sample weights.

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Table 1. Composition of nine experimental diets containing three percentages of protein and three levels of fish meal at each protein percentage, fed to Channel Catfish (3,000 per acre) in earthen ponds for 198 days.

Ingredients	Per cent ingredients in formula								
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Cottonseed meal (41%)	3.5	9.0	11.0	2.2	6.0	8.2	1.2	3.8	6.0
Soybean meal (44%)	19.5	~~39.0~~ 40.0	40.0	14.0	23.0	33.0	7.8	17.5	24.7
Peanut meal (50%)	9.5	19.0	29.0	6.9	14.8	22.4	4.0	10.0	17.4
Distillers dried sol.	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Alfalfa meal	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Ground wheat	36.5	22.0	6.0	38.6	24.9	11.8	38.1	25.2	14.0
Wheat bran	18.5	7.0	0.0	19.3	10.0	1.0	22.6	13.6	2.0
Animal or poultry fat	2.5	2.8	4.0	2.4	2.5	2.5	2.5	2.5	2.5
Fish meal (60%)	0.0	0.0	0.0	6.7	8.8	11.0	13.3	17.6	22.0
Dicalcium phosphate	1.8	1.8	1.8	1.0	0.8	0.5	0.3	0.0	0.0
Vitamin mix a	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Trace minerals b	+	+	+	+	+	+	+	+	+
Methionine	0.18	0.33	0.47	0.16	0.29	0.35	0.11	0.17	0.25
Determined protein (%)	28	36	43	29	36	43	29	35	43
Fraction of total protein from fish meal	0	0	0	1/6	1/6	1/6	1/3	1/3	1/3
Estimated metabolizable Energy (Kcal/lb)	1200	1200	1200	1200	1200	1200	1200	1200	1200

a/ Vitamin premix contained the following per pound of premix. Vitamin A, 300,000 IU, Vitamin D^3, 100,000 ICU, Niacin, 5,000 mg, d-Pantothenic Acid, 1,000 mg, Vitamin B^{12} Activity, 2 mg, Vitamin E, 2,000 IU, Riboflavin, 1,000 mg, Choline Chloride, 100,000 mg, Ethoxyquin, 13.6 gm, Menadione Sodium Bisulfite Complex, 2,000 mg, Pyridoxine Hydrochloride, 500 mg, Thiamine Mono-nitrate, 500 mg, Folic Acid, 100 mg.

b/ Trace mineral premix was used at the rate of 1.5 lb/ton of feed. One pound of premix contained the following: Mn, 79,000 mg, I, 900 mg, Cu, 3,632 mg, Zn, 60,382 mg, Fe, 29, 964 mg.

The ponds were harvested November 12 through November 16.

Measurements were made for each pond of total weights and numbers of fish and numbers of fish below 12 inches, which were considered below market size. Five fish from each pond were collected for measurement of dressing percentage and body chemical composition.

RESULTS AND DISCUSSION

The initial water temperature at 3 ft depth was 62.5 F but had increased to 70 F by May 1. Water temperature for most of the growing season ranged from 78 to 82 F at 3:00 P.M. The temperature at 3 ft at the end of the feeding period was 68 F.

There were no disease or serious water quality problems in any of the ponds. Aquatic weeds were dense in many ponds and seine sampling was difficult. A herbicide (Diquat) was applied equally in all ponds for weed control and caused a temporary low oxygen condition for several days during which time feeding was halted in all ponds until dissolved oxygen improved. The herbicide did not control weeds satisfactorily; however, fish production data from this study did not indicate that macrophyte growth adversely affected yield of catfish.

Generally, growth was good and in some treatments fish grew from 4-5 inches to an average size of one pound in 198 days, with over 95% of the fish being above 12 inches in length (0.5 lb). The averages for weight gain, percentage of fish over 12 inches, feed conversion, and returns above feed costs for each feed are presented in Table 2.

Table 2. Summary of average production responses from Channel Catfish in earthen ponds (3,000/acre) fed experimental diets of three total protein percentages containing three levels of fish meal for 198 days.

Diet	Yield/acre[1] lb	Harvestable fish, — 12 in. %	Feed Conversion	Feed cost/lb of gain $	Return above Feed cost/acre $
1 29% protein all plant	2330.0a	85.8	1.77	0.129	748
2 36% protein, all-plant	2475.0b	94.2	1.65	0.138	773
3 43% protein, all-plant	2640.0c	86.7	1.61	0.152	787
4 29% protein, 1/6 fish meal	2440.0ab	90.11	1.66	0.138	759
5 36% protein, 1/6 fish meal	2910.0d	96.16	1.39	0.134	920
6 43% protein, 1/6 fish meal	3010.0d	90.55	1.32	0.143	925
7 29% protein, 1/3 fish meal	2760.0cd	95.52	1.48	0.138	861
8 36% protein, 1/3 fish meal	2940.0d	97.63	1.48	0.162	847
9 43% protein, 1/3 fish meal	3030.0d	95.85	1.37	0.172	843

[1]All means not followed by the same superscript are statistically different ($P < 0.05$).

The results show that under these stocking and harvest conditions, i.e., 2,000 to 3,000 pounds production per acre, an all-plant feed can be formulated for satisfactory catfish production. However, when fish meal was omitted from the ration, the 43% total protein level produced the highest yield (P .05).

Although an all-plant diet is not the most desirable, the rising cost of fish meal may necessitate the use of all-plant diets for conventional feeding practices in static ponds. The medium protein (36%) diet containing low fish meal (8.8% of the diet) is probably representative of the most desirable practical feed for this system of catfish production. The yield for this feed was over 2,900 lb/acre with 96% of fish over 12 inches in length, and the return above feed cost per acre was next to the highest for the nine experimental feeds. The high protein (43%) diet containing low fish meal (11% of the diet) was slightly superior to the medium protein-low fishmeal diet in both yield and return above feed cost per acre.

Increasing fishmeal to the highest level, 1/3 of the diet protein, produced a significant growth response in the 29% protein in diet but not in the 36 or 43% protein diets. Previous research (Prather and Lovell, 1971) indicated that if the production rate per acre had been much higher than 3,000 lbs, through higher stocking density or larger size fish, the higher fishmeal and higher total protein levels would have been more beneficial.

Dress-out percentage increased slightly as protein level in diets increased, praticularly as protein increased from 29 to 36%. Body fat decreased as dietary protein increased. The probable reason for the lower dressing percentage of the fish on the lower protein diets was the higher amount of fat in the abdominal cavity. Body protein percentage was inversely related to body fat content (Table 3). Source of energy in the diets did not affect the fat content of the fish appreciably; for example, the low protein all-plant diet contained 36.5% ground wheat and the high protein all-plant diet contained only 6% wheat but 4% added animal fat (Table 1), yet the fat contents of the fish in the two treatments were not greatly different.

Table 3. Average dry weight percentages of fat and protein, dress-out percentage, yield of protein and yield of dressed fish per acre for Channel Catfish fed diets of three total protein percentages and containing three fish meal levels in earthen ponds for 198 days[1].

Diet	Body fat % of D.M.	Body Protein, % of D.M.	Dress-out, %	Yield Protein/acre, lb	Yield Dressed fish/acre, lb
Low protein, all plant	30.9	51.2	57.6a	1170	1316a
Med. protein, all-plant	32.6	55.9	59.4b	1349b	1458b
High protein, all plant	29.2	54.1	60.9c	1346b	1515bc
Low protein, 1/6 F.M.	32.1	55.0	60.1c	1314b	1436b
Med. protein, 1/6 F.M.	31.0	53.1	61.4c	1522c	1761d
High protein, 1/6 F.M.	23.8	58.3	60.8c	1667c	1831d
Low protein, 1/3 F.M.	37.1	51.1	58.8ab	1364b	1614cd
Med. protein, 1/3 F.M.	29.9	55.2	61.6c	1436bc	1602cd
High protein, 1/3 F.M.	30.5	52.5	62.9c	1562c	1870d
Low protein	33.4a	51.9a	58.8a		
Med. protein	31.1b	55.0b	60.8b		
High protein	28.5c	54.8b	61.5b		

Date	*Feed Allowance*
April 19 - June 19	4% of weight/day
June 20 - August 20	3% of weight/day
August 21 - October 10	30 lb/acre/day (2.5 - 1.5% of weight/day)
October 10 - November 12	40 - 30 lb/acre/day (1.5 - 1.3% of weight/day)

The available energy contents of all of the diets were calculated to be equal while protein levels varied, making the ratio of protein to energy different among the experimental feeds. Apparently, the higher ratios of protein to energy in the feed were responsible for lower percentages of body fat and higher dress-out percentages.

Yields of protein and dressed fish per acre were both higher for the higher protein and higher quality diets, showing a similar relationship with diet as did total yield of fish.

[1]Means having the same superscript are not statistically different at P .05

CONCLUSION

A satisfactory all-plant feed for pond-fed catfish can be formulated which is economical and will produce fish of uniform and desirable size; however, the protein level in such a feed must be considerably higher, than when fish meal constitutes a part of the formula. In this study, increasing protein percentage in an all-plant diet from 29 to 43 produced statistically significant and economical weight increases.

Results from this study indicate, that under the described stocking and feeding conditions in non-flowing ponds, a 36% protein feed containing 8.8% fish meal (and 1,200 kcal of metabolizable energy) is more practical for feeding channel catfish than 29 or 43% protein diets containing either less or more fish meal protein. With this feed, yields approaching 3,000 lbs/acre were attainable when 1/10-acre ponds are stocked at rates of 3,000, 4- to 5-inch fingerlings per acre and fed for 198 days at daily allowances not exceeding 40 pounds of feed per acre.

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