AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION	A. PRIMARY: Agriculture
	B. SECONDARY: Fisheries

2. TITLE AND SUBTITLE
Response of intensively fed channel catfish to diets containing various protein-energy ratios

3. AUTHOR(S)
Prather, E.E.; Lovell, R.T.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1973	5 p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Department of Fisheries and Allied Aquaculture, Auburn University, Auburn, Alabama 36830

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)
(In Proceedings of the 27th annual Conference of the Southeastern Association of Game and Fish Commissioners, p. 455-459)

9. ABSTRACT

Six experimental catfish feeds, containing 29, 36, and 42% crude protein at metabolizable energy (ME) levels of 1000 and 1300 kilocalories (kcal) per lb., were fed to fingerling channel catfish in 24, 1/10-acre earthen ponds for 165 days. Each dietary treatment was assigned randomly to four ponds which were stocked at a rate of 4,000 fish per acre. Feed allowance was increased bi-weekly on the basis of fish weight gain until a maximum daily allowance of 40 lb. per acre was reached. The higher energy plans resulted in greater weight gains, more fish protein produced per acre, and slightly fatter fish, at each dietary protein level. At the lower ME level the difference in growth among fish fed the 29, 36, and 42% protein diets was not significant (PV.05). At the higher ME level the fish showed increased gains with each increase in diet protein percentage. The high protein (42%)-low energy (1000 kcal) diet produced the lowest gain of the six treatments, indicating that high levels of protein may be toxic to catfish with low amounts of non-protein energy.

10. CONTROL NUMBER: PN-AAC-048	11. PRICE OF DOCUMENT

12. DESCRIPTORS
Catfishes
Channel catfishes?
Diets
Feeding stuffs
Protein metabolism

13. PROJECT NUMBER

14. CONTRACT NUMBER
CSD-2780 211(d)

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

Reprinted from the proceedings of the 27th Annual Conference of the Southeastern Association of Game and Fish Commissioners, 1973.

RESPONSE OF INTENSIVELY FED CHANNEL CATFISH TO DIETS CONTAINING VARIOUS PROTEIN - ENERGY RATIOS[1]

E. E. Prather and R. T. Lovell
Department of Fisheries and Allied Aquacultures
Auburn Agricultural Experiment Station
Auburn, Alabama 36830

ABSTRACT

Six experimental catfish feeds, containing 29, 36, and 42% crude protein at metabolizable energy (ME) levels of 1000 and 1300 kcal per lb, were fed to fingerling channel catfish in 24, 1/10-acre earthen ponds for 165 days. Each dietary treatment was randomly assigned to four ponds which were stocked at a rate of 4,000 fish per acre. Feed allowance was increased biweekly on the basis of fish weight gain until a maximum daily allowance of 40 lb per acre was reached. The higher energy plane resulted in greater weight gains, more fish protein produced per acre, and slightly fatter fish, at each dietary protein level. At the lower ME level the difference in growth among fish fed the 29, 36, and 42% protein diets was not significant (P<.05). At the higher ME level the fish showed increased gains with each increase in diet protein percentage. The high protein (42%) - low energy (1000 kcal) diet produced the lowest gain of the six treatments, indicating that high levels of protein may be toxic to catfish with low amounts of nonprotein energy.

INTRODUCTION

Prather and Lovell (1971) showed that channel catfish could be grown in earthen ponds from relatively small (4-inch) fingerlings to harvest-size fish (.9 lb) in a 200-day period when stocked at 4,000 per acre, provided a nutritious, high protein (44%) diet was fed. When a lower protein (32%) diet of comparable quality was fed, the average harvest size was 29% less (.63 lb). The advantage of the concentrated diet was manifested after the maximum daily feed allowance per acre had reached 30 to 40 lb and was not subsequently increased as the size of the fish increased. As fish size increased without an accompanying increase in daily feed allowance, the fish fed the concentrated diet received more nearly their optimum protein requirement than those fed the lower protein diet. Under price conditions at the time of study (1970) the net return per acre was greater for the higher protein diet. (When recalculated using the 1973 prices the net returns per acre were the same for the two feeds.)

Protein-energy ratio is important in concentrated catfish feeds because a low nonprotein energy level may cause expensive protein to be used for energy, or an excess of energy may be wasteful and produce fatty fish. Nail and Shell (1962) showed that by increasing digestible carbohydrate levels in channel catfish diets, more growth was obtained per unit of dietary protein. Tiemeier and Deyoe (1969) found that 25% crude protein and 850 kcal of metabolizable energy (ME) per pound were the most practical protein-energy levels for catfish grwon at the Kansas station. Hastings (1967) estimated that 1200 kcal of ME per pound was optimal for 32% protein feeds fed to catfish stocked at 1500 to 2000 fish per acre.

The purpose of this study was to evaluate various dietary protein-energy ratios for channel catfish stocked in earthen ponds at 4,000 fish per acre with the maximum daily feed allowance not to exceed 40 pounds per acre. Two energy levels were each evaluated at three crude protein percentages.

METHODS

Twenty-four 1/10-acre earthen ponds were each stocked with 400 4-inch channel catfish fingerlings. The intent was to stock 6-inch fish and harvest them approximately 200 days later when the fastest growing group should weigh near 1 lb; however, this size fish was not available and the smaller fish were used. The 24 ponds were randomly assigned to six experimental diets on May 9.

The composition of the six experimental diets used is shown in Table 1. Crude protein levels of 29, 36, and 42% and ME values of 1000 and 1300 kcal per lb were selected for the diets. The diets were formulated on the basis of crude protein and ME values for the ingredients as taken from livestock feeding tables (National Academy of Sceinces, 1969). The protein levels in the diets were modified primarily by altering the levels of equal parts of peanut meal and soybean meal. The nonprotein energy levels were regulated mainly by changing the amounts of corn, poultry fat, and soybean millfeed, the latter being of low nutritive value. The diet formulas were processed into 3/16-inch diameter pellets by a commercial feed manufacturer from inventoried feed materials.

One pond from each treatment was sampled monthly for weight estimates. Feed allowance was changed biweekly and based on average wieght of fish from all treatments. The feed allowance was calculated as a function of fish weight until the amount fed per day reached 30 lb, which was about mid-August. The mazimum daily allowance remained at 30 lb per day until mid-October when the allowance was increased to 40 lb per day. The daily feed allowance approximated 4% of the weight of the fish at the beginning of the experiment and 1.1% at the end.

Beginning November 20, one pond from each of the six treatments was drained each day over a 4 day period. The fish in each pond were counted, weighed and individual fish lengths measured. To evaluate composition of gain five fish from each pond were analyzed for proximate analysis.

RESULTS AND DISCUSSION

Figure 1 summarizes the growth responses of fish fed the six experimental diets. The most interesting effect was the poor response from the fish fed the high protein-low energy diet, which had the lowest gain and the poorest feed conversion (Table2). This diet, which had the narrowest protein-energy ratio, apparently contained too little nonprotein energy for this high level of protein. It contained no corn or animal fat, which were the primary sources of nonprotein energy in the other diets; only protein supplements and the nutritionally inert soybean millfeed. No doubt more of the protein in this diet was used by the fish for energy than in the high energy diets; however, other factors appear to have contributed to the poor response of these fish because their growth was significantly (PV.05) less than that of fish from diets of the same energy level but lower protein percentages. There appears to be a metabolic anomaly causea by the high level of protein in the presence of the low amount of nonprotein energy.

At the lower energy level, the difference in growth response among fish fed the 29, 36, and42% protein diets was not significant (PV.05). At the higher energy level, the fish showed successive growth increases at 36% and again at 42% dietary protein. The data indicate that at estimated ME levels of approximatley 1000 kcal/lb or less, channel catfish will not show additional growth response when the protein level in the diet is increased much beyond 29% under intensive stocking conditons. Thus, for high protein, concentrated catfish feeds, such as the Auburn No. 3 or the high protein diet in this study, ME levels appreciably higher than 1000 kcal/lb are essential.

The ratio of protein to energy is apparently an important factor in feeds for intensively cultured catfish. As shown in Table 2 the optimum ratio of protein (%) to ME (kcal/lb) in this tudy was 1:32 to 1:34. This is in agreement with Hastings' (1967) and Tiemeier and Deyoe's (1969) recommendations of 1:37 and 1:34, respectively. A ratio of 1:24 is probably hazardous, especially in high protein diets.

At the higher ME level, the 42% protein diet produced slightly more growth than the 36% protein diet and significantly (P<.05) more growth than the 29% protein diet (Table 2). If the fastest growing fish had reached the anticipated average size of 0.9 to 1.0 lb, the high protein would have probably shown greater superiority. Prather and Lovell (1971) found that the Auburn No. 3 (44% protein) produced 29% more growth in channel catfish, harvested at an average size of 0.9 lb, than a 32% protein diet of equal quality.

At each protein level the higher energy diet produced more pounds of fish, indicating that protein was spared by nonprotein energy in each case. Interestingly, the added energy came almost exclusively from corn in the intermediate and low protein diets, indicating that starch in corn is an effective sparer of protein for catfish.

Table 3 shows a comparison of the composition of gain for the fish fed the experimental diets. At each protein level the fish that were fed the higher energy level had more body fat. However, amount of protein produced per acre was also higher for the higher energy diet at each protein level, indicating that the added energy in effect did spare dietary protein for fish protein synthesis.

Under 1973 protein cost conditions the high protein diets were least economical and the low protein-high energy diet the most economical. Using 1972 prices the high protein-high energy diet was slightly more economical than the intermediate protein-high energy diet which was appreciably more profitable than the low protein diets.

Table 1. Ingredient composition of six experimental diets containing three percentages of protein at two energy levels that were fed to channel catfish in earthen ponds 165 days

Ingredient	Ratio of protein (%) to metabolizable energy (kcal/lb.)[1]					
	42:1300	42:1000	36:1300	36:1000	29:1300	29:1000
Fish meal	15	15	15	15	15	15
Soybean meal	31	30	23	22	16.5	15.5
Peanut meal	31	30	23	22	16.5	15.5
Distillers' dried solubles	5	5	5	5	5	5
Corn	15.5	-	33	10	42	19
Soybean millfeed	-	20	1	26	5	30
Poultry fat	2.5	-	-	-	-	-
Dicalcium phosphate	.8	.8	.8	.8	.8	.8
Pellet binders	2.0	2.0	2.0	2.0	2.0	2.0
Vitamin mix[2]	.5	.5	.5	5	.5	.5

[1]Crude protein and metabolizable energy values were estimated for the feed ingredients based on values in livestock feeding tables (National Academy of Sciences, 1969)

[2]Vitamin mix was identical to that used in Auburn No. 3 formula (Prather and Lovell, 1971)

Table 2. Average yields per acre and feed conversion ratios for channel catfish fed diets containing three percentages of protein at two energy levels 165 days in earthen ponds

Diets				
% Protein	Kcal energy per pound	Protein:energy ratio	Av. yield[1] (lb/acre)	Av. feed conversion
42	1,300	1:32	3,079 a	1.16
42	1,000	1:24	2,425 c	1.52
36	1,300	1:34	2,899 a,b	1.23
36	1,000	1:28	2,567 c	1.30
29	1,300	1:42	2,653 b,c	1.40
29	1,000	1:34	2,628[2] b,c	1.36

[1]Yield averages beside like letters are not statistically different at PV.05 by Duncan's Multiple Range Test (Snedecor, 1967).

[2]Average of only three ponds.

Table 3. Average body fat content and total pounds per acre of protein produced by channel catfish fed diets containing three protein percentages at two energy levels 165 days in earthen ponds

Diet				
% Protein	Kcal energy per pound	Protein:energy ratio	% Body fat	Pounds of fish protein/acre
42	1,300	1:32	12.6	1,541
42	1,000	1:24	9.7	1,268
36	1,300	1:34	11.7	1,457
36	1,000	1:28	10.7	1,377
29	1,300	1:42	12.7	1,237
29	1,000	1:34	10.4	1,162

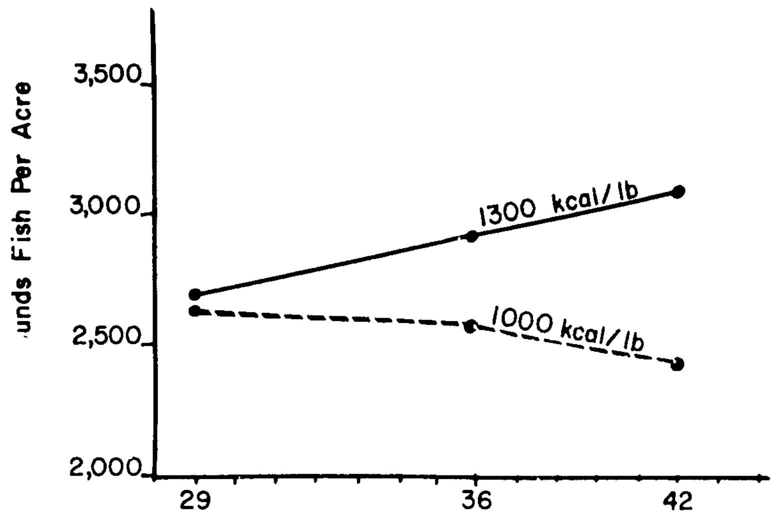

Figure 1. Yield of catfish per acre from diets containing three protein percentages at high and low energy levels fed for 165 days in earthen ponds.

---

[1]This study was a contribution to United States Department of Agriculture Cooperative State Research Service Regional Project S-83 and was partially funded by this project

LITERATURE CITED

Hastings, W. H. 1967. Warm-water fish nutrition. *In* Proc. Texas Commercial Fish Farming Conference, p. 27. Texas Agric. Ext. Ser. and Dept. of Wildlife Sci.

Nail, M. L. and E. W. Shell. 1962. The protein requirement of channel catfish *Ictalurus punctatus* (Rafinsque). Proc. 16th Ann. Conf. Southeast. Asso. Game and Fish Comm. (1962) 16:220-225.

National Academy of Sciences. Nation Research Council. Subcommittee on Feed Composition. 1969. United States-Canadian tables of feed composition. Publ. 1684 National Academy of Sciences. Washington, D. C.

Prather, E. E. and R. T. Lovell. 1971. Effect of vitamin fortification in Auburn No. 2 fish feed. Proc. 25th Ann. Conf. Southeast. Assoc. Game and Fish Comm. (1971) 25:479-483.

Snedecor, G. W. and W. G. Cochran. 1967. Statistical methods. Iowa State University Press, Ames, Iowa. 593 p.

Tiemeier, O. W. and C. Deyoe. 1969. A review of techniques used to hatch and rear channel catfish fingerlings in Kansas and proposed restrictions on nutritional requirements. Trans. Kan. Acad. Sci. 71(4):491-503.