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9. ABSTRACT

Four experimental diets, containing the same basal component but different amounts of fiber, were fed to thirty, 24-gram channel catfish in twelve, 20 square meter concrete ponds for 200 days. The basal components contained all known nutrients in amounts essential for growth, and were diluted with purified wood cellulose to contain 8, 12, and 20% fiber. Dissolved oxygen and ammonia levels in each pond were measured. In the next experiment, digestion coefficients for protein, available carbohydrate, and fat were determined for the diets containing the four levels of fiber. This was carried out in raceways using 400-500 gram channel catfish. Fish receiving the least fibrous diet grew significantly more ($P>0.05$) than those receiving greater amounts of fiber. During the last 30 to 60 days of the feeding period, dissolved oxygen averages were reduced for those receiving the higher fiber diets. Digestion coefficients for the three nutrients were essentially unaffected by the fiber content of the diets. The data from this study indicate that fiber does not appear to be a nutritionally important component of practical feeds for channel catfish. The slightly higher weight gains by the fish fed the diets containing the lowest fiber level cannot be related to nutrient digestibility. The cause for the difference in growth response may be due to fish not consuming all of the higher diets or to stress of poorer water quality during the latter phase of the experiment.

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EFFECTS OF DIET FIBER CONTENT ON FISH GROWTH, NUTRIENT DIGESTIBILITY, AND WATER QUALITY IN PRACTICAL CATFISH CULTURE

R. T. Lovell 1947, 9 p

Diets containing the same basal component but different amounts of fiber were fed to 24 g channel catfish in 20 m^2 concrete ponds for 200 days. The basal components were diluted with purified wood cellulose to contain 8, 12 and 20% fiber. Dissolved oxygen and ammonia levels in each pond were measured. Digestion coefficients for protein, available carbohydrate and fat were determined for the diets containing the four levels of fiber. This was done in raceways using 400-500 g channel catfish.

Fish that received the least fiberous diet grew significantly more ($P > 0.05$) than those receiving the greater amount of fiber. During the last 60 days of culture dissolved oxygen was reduced in the treatments receiving the higher fiber diet. Digestion coefficients for the three nutrients were essentially unaffected by fiber contents of the diets.

EFFECTS OF DIET FIBER CONTENT ON FISH GROWTH NUTRIENT DIGESTIBILITY, AND WATER QUALITY IN PRACTICAL CATFISH CULTURE

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INTRODUCTION

The minimum level of dietary fiber which will allow satisfactory growth by intensively fed catfish in production-type cultures is of importance. One reason is that fiber is assimilated poorly, if at all, by catfish (Smith, 1971); consequently most of that which is fed contributes to the biological oxygen demand (BOD) of the culture system. Another is that the rate of catfish production in static water is in many cases limited to the amount of organic matter that can be added to the culture pond per day; hence, the use of concentrated feeds, i.e., those with a low ratio of fiber to digestible nutrients allows the fish to receive more available nutrients per unit of organic matter put into the pond.

Buhler and Halver (1961) found that the addition of small amounts of cellulose to purified diets increased growth and efficiency of protein utilization by chinook salmon fingerlings. Dupree and Sneed (1966) fed channel catfish fingerlings with purified diets that contained equal amounts of nutrients but varied levels of cellulose. Their fish showed the highest gain from the diet containing 21% cellulose. Because feedstuffs used in practical feeds are coarser and less soluble than the nutrients in purified diets, it is possible that channel catfish do not require high levels of fiber to utilize such feeds effectively. The purpose of the present study was to determine the effect of different dietary fiber levels on growth and nutrient digestibility by channel catfish and on the level of dissolved oxygen in a static, production-type culture system.

MATERIALS AND METHODS

The growth experiment was conducted in 12 concrete ponds, each having a surface area of 20 m^2. Thirty, 24-g channel catfish of the Auburn strain from the same spawn were stocked into each tank.

Four experimental diets were prepared which contained the same basal component but different amounts of fiber. The basal component, shown in Table 1, contained all known nutrients in adequate amounts essential for satisfactory growth by channel catfish. Natural feedstuffs similar to those in commercial fish feeds were used as much as possible consistent with the need to control fiber content of the finished diet. The basal component contained 2% fiber. We diluted the basal component with purified wood cellulose (Solka-floc) to contain 8, 12 and 20% fiber. Proximate analysis and available carbohydrate content of the diets are presented in Table 2. Available carbohydrate was estimated by using copperiodometric titration (Smith, 1969) to measure the quantity of reducing sugars released by acid hydrolysis (Friedemann et.al., 1967); remaining analysis were carried out by AOAC (1965) methods.

We offered all fish the same quantity and quality of nutrients in their daily ration by increasing feed allowance in proportion to the dietary level of fiber, which was considered to be nutritionally inert. By assigning daily feed allowances proportional to 2.2, 2.4, 2.6 and 2.8% of the weight of the fish receiving diets 1, 2, 3 and 4, respectively, all fish received the same quantity of nutrients each day. Fish were fed once daily, 6 days per week for 200 days. Allowances were adjusted biweekly.

Minimum daily dissolved oxygen levels were determined in each pond by measuring at near sunrise with an oxygen meter. Ammonia nitrogen levels were determined for water samples from each pond on three successive mornings each month by the nesslerization procedure described in Standard Methods (APHA, 1971).

At the termination of the feeding trial, five fish from each tank were collected for determination of body fat content. Lipids were extracted from homogenized subsamples by a method based on the chloroform-methanol procedure of Bligh and Dyer (1959).

In a subsequent experiment, digestion coefficients for protein, available carbohydrate and fat were determined for the diets containing the four levels of fiber. One-half of one percent of chromium oxide was added to each of the diets which were subsequently fed in pellet form to 400 to 500-gram channel catfish in raceways. Water temperature was 25.5 C. The fish voluntarily consumed 2% of their weight in one daily feeding. After receiving the diets containing the indicator for 7 consecutive days, the fish were anesthetized 8 hours subsequent to feeding and 10 fish were taken from each tank and sacrificed for removal of ingesta from the lower gut. Only residue from the rectum, or that area of the gut distal to a sphinkter-like structure located 2 to 5 cm from the vent, was collected. The function of this sphinkter is not known but it seems to differentiate the more vascularized from the less vascularized areas of the intestine in channel catfish.

Table 1

Formula for Basal Component of Experimental Feeds

Ingredient	Percentage
Soybean meal (49% protein)	55.8
Fish meal (61% protein)	20.0
Pregelatinized corn starch	18.7
Soybean oil	5.0
Vitamin mixture	0.5

Table 2

Composition of Diets Containing Four Levels of Fiber

Diet	Added Fiber	Chemical Analysis (%)			
		Crude Fiber	Protein	Fat	Available CH_2O
1 (Basal)	0	2.0	40.2	8.4	32.2
2 (8% Fiber)	6	8.3	37.3	7.8	30.1
3 (14% Fiber)	12	15.0	34.0	6.8	28.5
4 (20% Fiber)	18	21.5	30.5	6.1	26.4

Feed and feces were analyzed for protein and fat by A.O.A.C. (1965) methods, available carbohydrate by the method of Friedemann et. al. (1967), and chromium oxide by the technique described by Furukawa and Ogasawara (1966). Nutrient digestion coefficients were calculated according to the method used in indirect determination of digestibility using an external indicator.

RESULTS AND DISCUSSION

Fish that received the least fibrous diet grew significantly more ($P < 0.05$) than those that received diets 3 or 4 as indicated by statistical test of adjusted mean gains (Table 3). Gain of fish fed diet 2 was intermediate between gains of fish fed higher or lower levels of fiber but did not differ significantly from that of either group. The superior growth made by fish fed the 2% fiber diet makes it appear that fiber does not play a significant role in the utilization of production-type feeds by channel catfish.

The discrepancy between our findings and those of Dupree and Sneed (1966) mentioned earlier may be attributable to physical differences between the purified and practical diets fed in the studies. The added cellulose probably increased resisdence time of the purified, readily soluble ingredients in the digestive tract, thereby allowing increased uptake of nutrients as proposed.

The natural feedstuffs we used to compound the basal experimental diet were apparently physically adequate for satisfactory nutrient absorption in the gut of channel catfish. It appears that the added cellulose did not facilitate absorbtion of nutrients in our feeds, nor did it appreciably retard digestibility (Table 4). The digestion coefficients for the three nutrients were essentially unaffected by fiber contents of the diets, with the possible exception of protein and available carbohydrate in the 20% fiber diets.

Body composition was significantly related to fiber content of the diets. Although dietary fiber levels may affect carcass composition in livestock, the nonnutritive fraction of the diet does not seem to affect carcass quality in channel catfish.

Effect of dietary fiber level on dissolved oxygen was not statistically significant ($P < .05$) over the entire growing season. During most of the experiment, average dissolved oxygen values were similar for the various diets. However, as shown in Figure 1, during the last 30 to 60 days of the feeding period the higher fiber diets were responsible for lower dissolved oxygen averages. This was when feeding rate was highest and after unassimilated feed had accumulated during the course of the experiment. We interpreted this relationship between dietary fiber and oxygen content of the pond water to indicate that the lower-fiber feeds were not so detrimental to water quality as the higher fiber diets because they did not contribute as much unusable organic matter to the ponds.

Table 3

Average Gains, Feed Conversion Ratios and Body Fat Content of Channel Catfish Fed Diets Containing Four Levels of Fiber

Criterion	Diets			
	1	2	3	4
Gain, lb./acre	3,132[a]	2,705[a,b]	2,468[b]	2,532[b]
Conversion:				
Basal	1.16	1.15	1.21	1.21
Total diet	1.16	1.23	1.37	1.47
Body fat, % of D.M.	31.8	30.9	31.3	31.2

Table 4

Apparent Digestibility of Protein, Starch and Fat in Diets Containing Four Levels of Fiber by Channel Catfish

Nutrient	Diets			
	1	2	3	4
Protein	86.5%	84.1%	87.6%	83.0%
Starch	75.6%	70.6%	78.0%	69.9%
Fat	60.6%	76.7%	63.8%	61.9%

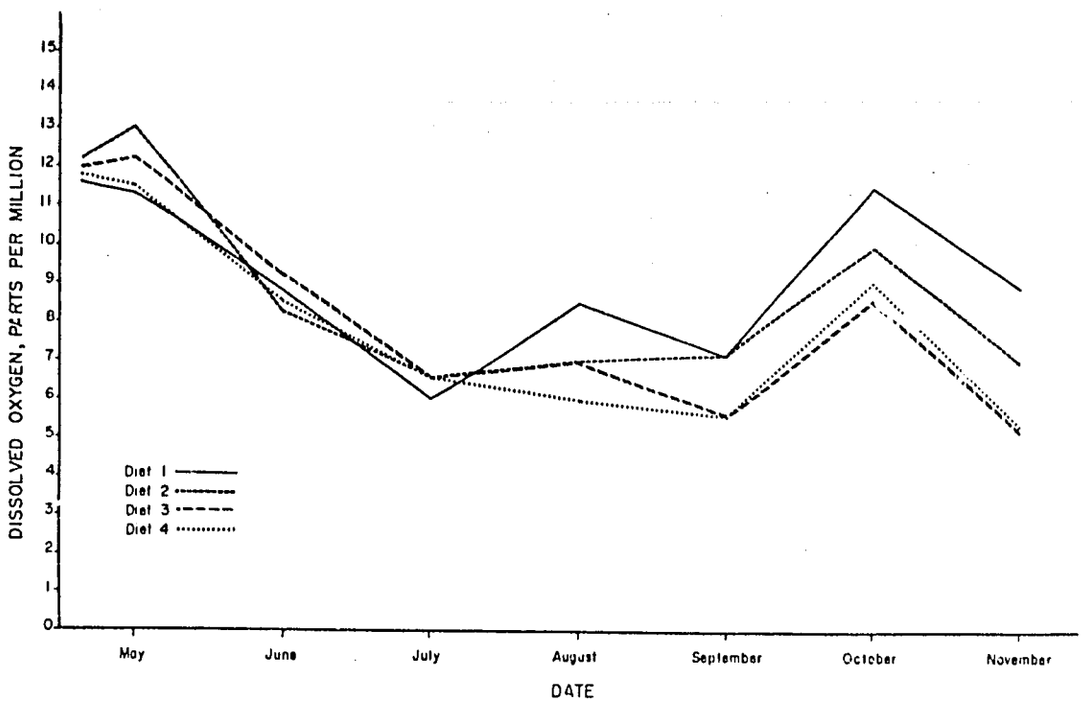
DISSOLVED OXYGEN, PARTS PER MILLION
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Diet 1
Diet 2
Diet 3
Diet 4
May
June
July
August
September
October
November
DATE

Figure 1

Ammonia levels in the pond water increased throughout the trail from 0.5 initially to almost 6.0 parts per million at the end, but influence of diet was not evident.

CONCLUSION

The data from this study indicate that fiber does not appear to be a nutritionally important component of practical feeds for channel catfish. The slightly higher weight gains by the fish fed the diets containing the lowest fiber level cannot be related to nutrient digestibility. Cause for the difference in growth response may be due to fish not consuming all of the higher fiber diets or to stress of poorer water quality during the latter phase of the experiment.

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