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UTILIZATION OF CASEIN AND SOYBEAN PROTEIN BY CHANNEL CATFISH, *ICTALURUS PUNCTATUS* (RAFINESQUE)

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ABSTRACT

This research was conducted at the Fisheries laboratory at Auburn University Agricultural Experiment Station to determine the comparative value of casein, soybean protein, and a 1:1 combination of these two proteins in diets of channel catfish. The proteins or combination of proteins were fed at a 5 or 30 per cent level. The comparative values of the proteins were evaluated by growth rate of lots of 10 channel catfish held in troughs and fed the purified diets during a 10-week period.

The growth rate data indicated that diets containing casein and the protein combination produced approximately equal growth and that both of these protein sources produced better growth than soybean protein alone. Fish receiving diets containing 30 per cent protein gained at a significantly higher rate than fish receiving diets containing five per cent protein. The relative order of growth rates for the three sources of protein was the same at both levels of protein in the diet.

INTRODUCTION

The channel catfish is one of the most promising species of fish in the United States for culture in ponds. Results of experiments conducted by the Farm Ponds Project of Auburn University Agricultural Experiment Station showed that the channel catfish can be cultured profitably both as a commercial fish and as a sport fish (Swingle, 1956, 1958; Prather, 1959). These experiments also demonstrated that supplemental feeding is necessary to obtain high production.

Some research has been conducted at Auburn to provide information on which to base an adequate program of supplemental feeding

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for producing channel catfish in ponds. By feeding purified diets to fish in troughs, Dupree (1960) determined certain vitamin requirements of channel catfish, and Nail (1962), studied the effects of different levels of carbohydrate on protein requirements in the diets of this species. However, little research has been conducted on the comparative value of various protein sources in supplying the protein requirements of the channel catfish.

The experiment described here was designed to determine by feeding trial the comparative value of two purified proteins (casein and soybean protein) and a 1:1 combination of these two proteins in purified diets, and to determine whether the comparative value was affected by the level of protein in the diets.

EXPERIMENTAL PROCEDURE

For use in this experiment, 8-month channel catfish, 5 to 7 inches in length, were obtained from a rearing pond of the Farm Ponds Project of the Alabama Station at Auburn in mid-December of 1962. The fish were held in stainless steel troughs throughout the experiment. Water from the city system was passed through an activated charcoal filter to remove chlorine before being piped into the troughs. A constant flow of water was maintained at a rate to provide approximately two changes per hour through each trough. Water temperature was measured by a recording thermometer. The average temperature range during the period (June 30 until September 8, 1963) was 27°C. to 28°C. The troughs were cleaned at intervals to remove uneaten food and accumulated fecal materials, and to reduce growth of algae on the metal surfaces.

The fish were fed the experimental diets beginning in mid-March of 1963; however, no data were taken until after June 30, 1963, because of a low-level infection of columnaris disease in the fish. At the beginning of the experimental period reported here, each of 30 troughs contained a lot of 10 fish weighing from 310 to 510 g. per lot.

Purified casein, purified soybean, and a 1:1 combination of these two proteins were utilized as sources of protein. Each of the proteins, or the protein combination, was incorporated into purified diets at a 5 or 30 per cent level. In addition to the proteins, white dextrin (20 per cent level), corn oil (10 per cent level), USP XIII salt mixture No. 2 (4 per cent level) and a vitamin fortification mixture (2 per cent level) were added as ingredients of the diet. Alphacellulose flour was added to all diets as bulk so that the same weight of food would be fed to each lot of fish regardless of protein content of the diet. The compositions of the diets are given in Table 1.

Each experimental diet was prepared by adding the dry ingredients to a five per cent aqueous agar solution and mixing. The re-

Table 1. Composition of diets in percentage of dry ingredients.

Ingredient	Experimental diet					
	Casein (5) ¹	Casein (30)	Soybean (5)	Soybean (30)	Casein plus soybean (5)	Casein plus soybean (30)
Casein ²	7.4	44.1	0	0	3.7	22.1
Soybean protein ³	0	0	5.6	33.5	2.8	16.8
Dextrin	20.0	20.0	20.0	20.0	20.0	20.0
Corn oil	10.0	10.0	10.0	10.0	10.0	10.0
Salt mixture	4.0	4.0	4.0	4.0	4.0	4.0
Vitamin mixture	2.0	2.0	2.0	2.0	2.0	2.0
Agar	5.0	5.0	5.0	5.0	5.0	5.0
Alphacell	51.6	14.9	53.4	25.5	52.5	20.1

¹ Percent protein in the diets.

² Contained 68.8 percent protein.

³ Contained 89.5 percent protein.

sulting warm paste was cooled to approximately 50°C. and forced through a meat grinder. The grinder formed the paste into long strings approximately three-sixteenths inch in diameter. The paste was forced through the grinder two additional times to ensure thorough mixing of all ingredients. When the last grinding was done, the temperature of the material was approximately 27°C. At this temperature the agar solidified so that the "strings" of paste usually broke into short pieces of pellets. The diets were kept in 1-gallon jars, tightly wrapped in polyethylene bags and stored in a refrigerated room at a temperature of 5°C. until fed to the fish.

The fish were fed at a rate of 2 percent of bodyweight of dry diet (4 percent wet weight) per day. The daily ration was given in a single feeding at about 5 o'clock in the afternoon.

The fish in each lot were weighed at 2-week intervals during the 10-week experimental period to determine the growth response of the fish to the different diets, and to adjust the daily ration as the fish increased in weight.

A 2 x 3 factorial design with five replications in each treatment combination was used in this experiment. Factor A, the source of protein, was applied at three levels—casein, soybean protein, and a 1:1 combination of the two proteins. Factor B, the percent of protein in the diets, was applied at two levels, 5 and 30 percent.

RESULTS AND DISCUSSION

The growth response (gain in weight) of channel catfish obtained in this experiment is expressed as a percentage of the weight of that lot of fish at the beginning of the experiment, and it will be identified as growth rate throughout this report.

The growth rates of fish receiving the different diets are presented in Figure 1. Each point represents the average growth rate of five lots of fish receiving a given diet at the end of 2, 4, 6, 8, or 10 weeks. From the data presented it can be seen that fish fed diets containing 30 percent protein grew at a much higher rate regardless of the protein source than those receiving diets containing 5 percent protein. It is also evident that at each level of protein nutrition there were significant differences in growth depending on the protein source.

For a quantitative evaluation of the data presented the growth rates of the 30 lots of fish at the end of 10 weeks were used in an analysis of variance. This indicated that a significant amount of the variation could be attributed to both the kind and level of protein in the diets. Variation associated with interaction between the two major factors was not significant at the 5 percent level of confidence, but was significant at the 10 percent level. Although the degree of interaction was not great enough to invalidate the tests for main effects, these results do indicate some degree of interaction between the kind of protein and level of protein at the two levels. This low level of interaction is primarily a result of the casein and combination protein diets changing position in rank at the 5 percent and the 30 percent level.

Since there were only two levels associated with percentage of protein in the diets, the analysis of variance indicated, as does the chart, that fish receiving diets containing 30 percent protein grew at a significantly higher rate than fish receiving diets containing 5 percent protein. This result was expected when the experiment was designed. The two levels of protein were included so that the comparative value of the three different protein sources could be compared at a high and low level of protein nutrition. It is interesting that there was growth at the 5 percent level. Even fish receiving the soybean protein grew at this level of protein nutrition. Nail (1962) demonstrated that the channel catfish could gain weight on diets providing 0.16 g. of protein in the form of casein per 100 g. of fish per day. In this study channel catfish gained weight on a diet providing 0.10 g. of protein per day.

Comparisons of means of individual treatments are of primary

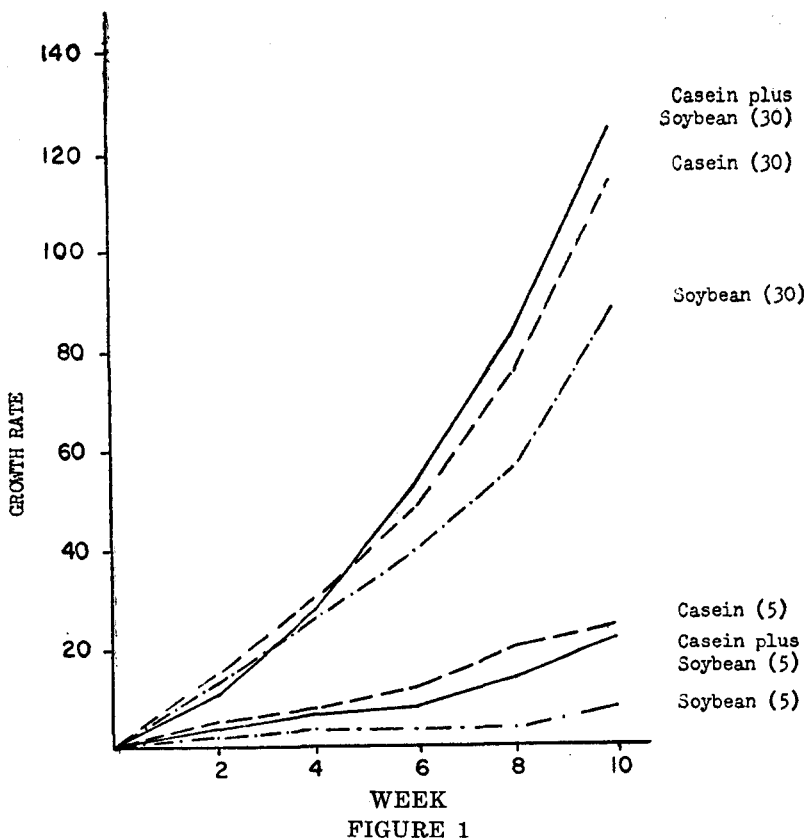


FIGURE 1
Average growth rates at the end of 2, 4, 6, 8 or 10 weeks of lots of fish receiving the different diets

interest in this experiment. The comparisons were made by Duncan's New Multiple Range Test (Steel and Torrie, 1960). The results of the comparisons are shown in the following table. In the table means not underscored by the same line are significantly different at the 5 percent confidence level.

Protein level (Percent)	Rank of treatment means ¹		
	Soybean (6.1)	Combination (19.7)	Casein (22.7)
5	Soybean (86.1)	Casein (110.6)	Combination (123.2)

¹ Average growth rates.

Comparisons of treatment means in the previous table indicate a significant difference in growth rate of channel catfish fed on casein or soybean protein when included in the diets at the 5 or the 30 percent level. Casein maintained approximately the same degree of superiority over soybean protein at both levels. It is apparent from these results that casein contains relatively more of the required factors for adequate protein nutrition than does soybean protein.

In feeding trials with rats, Mitchell (1924) found that casein

was more digestible than soybean protein. Maner, et al. (1961) demonstrated in feeding trials with rats and pigs that diets containing casein were superior to diets containing soybean protein when compared on the basis of food conversion, digestibility, and nitrogen-retention. They suggested that this difference was mainly due to the deficiency of methionine and cystine in the soybean protein. The results of feeding trials with these other animals suggest a deficiency of either methionine and cystine (or other amino acids) or a low digestibility as the cause or causes of the relatively low growth rates of channel catfish receiving diets containing soybean protein.

Whether fed at the 5 or 30 percent level, the diets containing the protein combinations produced significantly higher growth rates than the diets containing soybean protein alone. Contrary to the results obtained in the comparison between casein and soybean protein at the 5 and 30 percent levels, the superiority of the combination of proteins over the soybean protein is significantly increased at the 30 percent level.

There was no significant difference between growth rates produced by the protein combination diet and by the casein diet at either the 5 or 30 percent level. At both levels casein and soybean protein in the combination diet supported each other to the extent that growth was as good as on the casein diet. The means are more widely separated at the 30 percent level, but, with the experimental error involved, the difference is not significant. These results indicate that casein contains an excess of the amino acid or acids lacking in soybean protein. There apparently was enough excess amino acid or acids in casein to balance the total body fluid amino acid pool or to create a pool similar in quantity and quality to the pool resulting from the casein diet.

CONCLUSIONS

Feeding trials to determine the comparative value of two purified proteins (casein and soybean protein) and a 1:1 combination of these two proteins in diets for channel catfish indicated the following conclusions: (1) Growth rate was significantly higher on diets containing 30 percent protein than on diets containing 5 percent protein. (2) Fish receiving the casein diet and the combination diet at both the 5 and 30 percent levels grew at a significantly higher rate than fish receiving the soybean diet. (3) There was no difference in growth rates of fish receiving the casein diet or the combination diet at either the 5 or 30 percent level.

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