OXIDATION POND ALGAE AS A SUPPLEMENT FOR COMMERCIAL CATFISH FEED

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ABSTRACT

Investigations have shown that small (less than 10 cm) channel catfish finglerlings, *Ictalurus punctatus* Rafinesque, gained as much weight in a 10 week period on a diet of 25%-75% oxidation pond algae-commercial feed as did control animals fed 100% commercial feed. Larger fish (20-25 cm) fed the algal-supplemented diet did not gain as much weight in 10 weeks as did control fish on 100% commercial feed. Whole body protein and fat levels did not differ significantly between control and experimental fish.

INTRODUCTION

There are several major problems facing the catfish industry today. One is the high cost of commercial feed. A second is the discharge of effluent from the various catfish operations, especially raceways. Our goal is to improve the quality of commercial catfish feeds while reducing the cost by supplementing the food with unicellular green algae grown in oxidation ponds. In addition, we hope to develop a practical and efficient solution to deal with the increasing problems resulting from the effluent of catfish operations.

We have previously investigated the feasibility of supplementing commercial catfish feeds with various strains of freshwater, unicellular green algae (Chlorophyta) grown in oxidation pond water which is similar in composition to the effluent discharge from commercial catfish operations (Samsel, Reed and Daub, unpublished). This preliminary study demonstrated that channel catfish, *Ictalurus punctatus* Rafinesque, (fingerlings) fed algae grown in oxidation pond cultures and supplemented in a 25%-75% algae to commercial feed ratio, gained as much weight as similar fingerlings fed 100% commercial catfish feed.

We have been able to successfully grow the algae used as a supplement in mass culture in our laboratory and also in oxidation ponds. Laboratory culture of the experimental algae has yielded adequate quantities for laboratory supplementation with commercial feeds. In addition, one acre oxidation pond cultures have yielded, in the absence of blue-green algae, enough green algae to supplement up to 25% of the feeding requirements for four 50 foot outdoor catfish raceways.

The present study investigated the utilization of algal-supplemented commercial feeds by larger channel catfish (20-25 cm, 60-80 g) in larger aquaria (76 liters and 132 liters). Analysis of feeds and fish tissues was done to determine protein and fat content. The results of this study are compared to those of similar investigations using small fish (less than 10 cm, 4-11 g) and smaller aquaria (37 liters).

MATERIALS AND METHODS

The freshwater algae used for supplementation consisted of five genera, *Chlamydomonas, Euglena, Chlorella, Chlorococcum* and *Chlorogonium*, all typical oxidation pond inhabitants and all isolated from gut cultures of fingerling and adult channel catfish.

Algae isolated from catfish guts were grown in natural oxidation pond water artificially enriched with various salts to approach nutrient concentrations observed from commercial catfish operations (Chapman, Chesness and Mitchell, 1971). Algal cultures were maintained in growth chambers at 20±3 C in 76 liter aquaria under continuous aeration and with a 12-12 hour light-dark photoperiod.

Nine days were required for the algae to reach harvest limits. Algal harvesting was accomplished by centrifugation. The unicellular green algae were freeze-dried for 48 hours and prepared for supplementation.

The freeze-dried oxidation pond algae were weighed and mixed with crushed commercial floating catfish feed (Splash Fish Food, # 4, National Pet Food Corporation, Monmouth, Ill.) in a 25%-75% ratio by weight of algae to feed. This mixture was then sprayed with water and hand-rolled into 3 mm pellets similar to the commercial floating feed pellets. Pellets were stored in air tight containers and refrigerated until use.

Channel catfish fingerlings, 20-25 cm, were obtained for the study from a local hatchery. The fish were allowed to acclimate for one month under laboratory conditions. During the acclimation period the fingerlings were fed the same commercial feed used in the experimental studies.

These studies employed two 76 liter glass aquaria, each containing five catfish fingerlings. The aquaria were kept at 27±1 C under a 12-12 hour light-dark photoperiod for 10 weeks. In addition a pair of 132 liter aquaria each containing seven catfish fingerlings was maintained for a five week study.

Continuous aeration and filtration were employed in all aquaria. During all experiments fish were fed approximately 3% of their body weight per day. Fish of similar weight and length were used in all tests (Tables 1 and 2). One aquarium of each pair served as a control with the fish fed 100% commercial feed. The fish in the other aquarium of each pair were fed the 25%-75% algae-feed supplement.

Weights of all fish in each aquarium were recorded at the initiation of the experiment, after five weeks, and in the 76 liter aquaria, after 10 weeks of supplemental feeding. The frequency of weighing was kept to a minimum to reduce fish handling and possible mortality. Periodic monitoring of fish behavior and general appearance was done throughout the experiment. No fish died during the study.

Weight data shown represent the mean values for all fish in each group. Select water quality parameters, i.e., dissolved oxygen, temperature, ammonia-nitrogen and pH were monitored bi-weekly. Dissolved oxygen remained at approximately 6.5 ppm during the study period. Temperature was maintained at 27±1 C with the aid of thermostatically-controlled aquarium heaters and the pH remained at 6.7. Ammonia-nitrogen values ranged from 0.4 to 0.6 ppm.

Protein and fat analyses were made in duplicate on samples of all feed products. These included commercial feed, algal-supplemented feed and algae alone. Also whole body protein and fat analyses were determined in duplicate for experimental and control fish. Protein determinations were based on a modified Kjeldahl Method from the A.O.A.C. Handbook (Horwitz, 1970, section 24.0056, p. 392) and the test for crude fat levels used the ether extract procedure also from the A.O.A.C. Handbook (Horwitz, 1970, section 2.049, p. 16). Values for the fish are reported in percentages based upon wet weight for whole animals. The complete body of individual fresh fish was macerated, weighed and frozen prior to testing. Feed analyses were based on the dry weights of the samples.

RESULTS

Earlier 10-week experiments showed an average net gain of 5.5 grams per fish fed a non-supplemented feed and an average net gain of 5.4 grams for fish fed an algal-supplemented food (Table 1). As stated, the present study entails the use of larger fish in larger aquaria. Channel catfish in a 132 liter aquarium fed 100% commercial catfish feed gained an average of 3.5 grams per fish in a five week period. Similar fish fed a 25%-75% algal-supplemented food gained 2.3 grams (Table 2).

Control fish in the 76 liter aquarium gained an average of 4.2 grams in five weeks while experimental fish gained 2.5 grams. This portion of the study was continued for an additional five weeks with the controls showing an average net gain of 11.3 grams after 10 weeks. The test fish which were fed the 25%-75% algal-supplemented feed gained an average of 8.0 grams per fish after 10 weeks. As in earlier studies conversion ratios were similar for both control and algal-supplemented feeds (Tables 1 and 2).

Feed analyses yielded the following test results: Commercial catfish feed had 32% protein and 4% fat. Algae as a composite contained 23% protein and 6% fat, while the algal-supplemented commercial feed contained 29.7% protein and 5.3% fat. The test fish were being fed 2.3% less protein than the control fish.

Whole body analyses of catfish fingerlings in earlier studies showed that 25-30 gram fish (less than 15 cm) had a mean protein content of 14.06% for controls and 13.31% for the test animals. The fat values were 7.75% and 9.25% respectively. Protein levels in macerated whole body samples of 60-80 gram fish (20-25 cm) averaged 13.15% for controls and 13.66% for test fish. The fat levels were lower than in previous studies with smaller fish, averaging 4.05% for controls and 4.10% for experimental fish. No tissue analysis was done on fish less than 15 cm (40-45 g).

These values above may be compared to 14.4% protein and 20% fat in the edible portion of adult commercial catfish as reported by Winton and Winton (1949, pp. 435-438). The same authors reported 4% fat and 19% protein for perch, 12.8% fat and 21% protein for salmon and 2.1% fat and 19% protein for brook trout. In this study the diet fed to both large and small channel catfish resulted in nearly identical protein and fat levels in their respective bodies.

DISCUSSION

The results of this study and those of previous studies (Table 1) indicate that small channel catfish fingerlings, less than 10 cm, are better able to utilize a 25%-75% algal-supplemented commercial feed than are fish 20 cm or greater in length. The weight gain by small fish cannot be attributed to commercial feed alone since the increase relative to the control fish was greater than 75% (Table 1). However the weight gain of larger fish relative to controls was less than 75% and therefore this gain may be due solely to the commercial component of the experimental feed mixture (Table 2).

As noted in the feed analyses, the algal-supplemented commercial feed had a protein content 2.3% less than pure commercial feed. Yet the small catfish fingerlings were able to utilize the experimental feed as well as they did the commercial feed (Table 1). Such was not the case for larger fish, 20-25 cm, which did not gain weight as rapidly on the experimental feed (Table 2). It is not known whether the plant digestive capabilities differ with age and size in channel catfish fingerlings but this may be a possible explanation.

The observed differences in growth rate are not thought to be attributed to the physical laboratory design, however further studies are underway to evaluate other combinations of algal-supplemented commercial feed using more standardized aquaria for all sizes of fish tested. In addition, these studies are examining the growth of channel catfish in experimental raceways as well as comparing the digestive physiology of catfish of various ages and sizes.

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Table 1. Growth of small channel catfish fingerlings fed algal-supplemented feeds in 37 liter aquaria.

	∓ wt. 0 days (grams)	(range)	∓ wt. 5 wks (grams)	(range)	∓ wt. 10 wks (grams)	(range)	∓ net gain 10 wks.	relative gain % controls equal 100	conversion ratio 10 wks
Control - 100% commercial feed	4.0	3.5-4.5	6.7	5.6-7.5	9.5	7.0-11.0	5.5	100	11:1
25% - 75% oxidation pond algal supplement	4.1	3.6-4.6	6.7	5.4-7.2	9.4	8.0-11.1	5.4	98	10:1

Table 2. Growth of large channel catfish fingerlings fed algal-supplemented feeds in 76 and 132 liter aquaria.

	$\mp$ wt. 0 days (grams)	(range)	$\mp$ wt. 5 wks. (grams)	(range)	$\mp$ wt. 10 wks. (grams)	(range)	$\mp$ net gain 10 wks. (grams)	relative gain (%) controls equal 100	conversion ratio 10 10 wks.
Control - 100% commercial feed (76 liter) aquaria	75.1	60-80	79.3	61-84	86.4	67-89	11.3	100	9:1
25% - 75% oxidation pond algal supplement (76 liter) aquaria	70.5	60-80	73.0	61-83	78.5	62-81	8.0	70	10:1
Control - 100% commercial feed (132 liter) aquaria	80.4	60-80	83.9	61-86	-	-	3.5*	100	10:1
25% - 75% oxidation pond algal supplement (132 liter) aquaria	73.5	60-80	75.8	61-83	-	-	2.3*	66	11:1

*Study terminated after 5 weeks.