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EVALUATION OF A FULL-FAT SOYBEAN RATION FOR CHANNEL CATFISH PRODUCTION IN CAGES*

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ABSTRACT

An experimental ration consisting of 50% full-fat soybeans, heated 170°C, was compared to a commercial trout chow in a 120-day feeding trial using two stocks of channel catfish, *Ictalurus punctatus* Rafinesque. Catfish were reared in 0.9 m^3 floating cages, with 200 fish per cage, anchored in a 1.5 hectare farm pond. A Central Arkansas stock significantly outperformed a Southeast Arkansas stock for comparisons of net production and food conversion efficiency (FCE), with 92% greater production and 41% better FCE, respectively. Survival was 90% or greater for all fish. There was no significant difference in dress-out weight between the stocks. However, the catfish fed the trout ration had significantly lower amounts of body fat. The commercial trout chow overall was significantly better for fish production than the full-fat soybean ration. Production with trout chow was 84% greater than with the full-fat soybean ration. Food conversion efficiency was nearly 41% better with the trout ration, while percent body fat was 11% less. There were no differences in percent survival and percent dress-out weight between the rations. The Central Arkansas stock fed the commercial trout ration had the lowest production cost of 0.47¢ per 0.45 kg live weight, while the Southeastern stock had a higher production cost with either feed.

INTRODUCTION

Cage culture of fishes has been practiced in Asia since the early part of this century (Hickling, 1962), but it has been during the past six-eight years that intensive cage culture operations have become feasible for channel catfish (Kilambi et al., 1977; Newton and Merkowsky, 1977). This has been due largely to the development of high protein, nutritionally complete diets. Caged catfish culture ration studies have been conducted at UAPB since 1975 (Newton and Merkowsky, 1976). Most diets for caged catfish culture have consisted of high percentages of animal proteins with little utilization of vegetable proteins. High percentages of animal proteins increase production costs of complete rations. In an attempt to reduce protein ingredient costs, researchers have attempted to substitute vegetable proteins for some of the animal proteins. Soybeans has been one of the major substitutes considered in reducing the amount of animal proteins. The chemical composition of soybeans and their amino acid profile rank them as one of the better plant products for consideration in fish diets. However, soybeans that are not heat-treated are not completely utilized by monogastric animals (Smith, 1977). Brandt (1979) determined that heat treating soybeans to 170°C destroyed growth inhibitors (hemagglutinins, goitrogens, protease inhibitors). His studies at the Stuttgart Fish Farming Experimental Station have indicated that in pond culture, properly heat-treated soybeans in a balanced diet provided good growth, production, and survival for channel catfish.

The objectives of this study were (1) to assess the performance of caged channel catfish fed a 50% full-fat heat-treated soybean ration, and (2) to compare two catfish stocks' performance fed the soybean ration and a commercial trout ration.

METHODS AND MATERIALS

Catfish fingerlings were obtained from Central and Southeast Arkansas representing two stocks of channel catfish. Floating cages (0.9 m^3) were anchored in a 1.5 hectare farm pond at the UAPB Agriculture Experiment Station (Newton and Merkowsky, 1976). Fingerlings were stocked at the rate of seven fish per 28.3 dm^3 (200 fish per cage). Each stock of catfish was fed both the commercial trout ration (TC - 36% protein) and a 50% full-fat soybean ration (FFS - 36% protein) formulated by Brandt *(pers. comm.)*. Experimental conditions were triplicated for fish stocks and rations. The 50% full-fat soybean ration was prepared by the Kansas State University Department of Grain Science and Industry, Manhattan, under the supervision of Dr. Keith Behnke. The experimental ration formula is on file in the UAPB Fisheries Library.

Fish were placed in the cages and preconditioned for five days before the experiment was initiated 24 April 1979. The catfish were fed six days per week for a total of 120 feeding days. All fish were fed 3% of their estimated body weight according to a schedule that was adjusted bimonthly based upon a 1.5:1 feed conversion ratio. Periodic samples were taken of at least 10% of the population to check for growth and to adjust the feeding schedule.

On 19 September, all fish were harvested and the total number and total weight were recorded for each cage. A 10% random sample of the fish was used to determine dress-out percentage, the portion of a fish available for market sale, and percent body fat, mesenteric fat of individual fish.

Both rations were tested for physical characteristics of size, number, percent moisture, and floatability. Average number of pellets per ten grams and average sizes were determined from ten samples of each ration. Percent moisture was determined from three samples of each ration with a Blue M drying oven at 100°C for 48 hr. Floatability was tested in a 75 l aquarium. A 300 pellet sample of each ration was placed in the aquarium with a water temperature of 27.6°C and observed for two hours. The pellets were then checked at the end of 24 hr and floating pellets counted. Significant differences among net production, survival, percent dress-out, percent body fat, physical characteristics of the feed, and average weight of the fish were tested by factorial analysis (Steel and Torrie, 1960). All statistical tests were compared at the 0.05 level of significance.

RESULTS AND DISCUSSION

There were no significant differences among the mean diameter pellet size (9.5 mm), percent moisture (9.9), or floatability (99%) between the two rations. However, there was a significant difference in the number of pellets per sample (TC:FFS = 1:1.5). The full-fat soybean pellets were 34% bulkier. Lovell (1977) noted that a bulky ration may be disadvantageous for good channel catfish growth. Thus decrease in growth may be accounted for because the catfish do not consume enough feed to meet their nutritional requirements. It was

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observed that the caged catfish routinely consumed all pellets within 20 minutes after feeding.

The Central Arkansas stock, compared to the Southeastern stock, had a significantly higher average net production and food conversion efficiency for both rations (Table 1). The Central Arkansas stock had a 92% greater net production than the Southeastern stock when fed the trout ration, and a 99% greater net production when fed the full-fat soybean ration. Comparisons between feeds revealed that both stocks had 84% increased production with the trout ration than with the soybean ration.

There was no significant difference in survival between the two stocks for either ration. The Central Arkansas stock produced a larger average-sized fish with either ration (Table 1). The trout ration produced the better average weight gain for both stocks.

There was no significant difference in the percent dress-out weight between the two stocks; however, there was a significant difference in the amount of mesenteric fat in the body cavity of the fish between the two feeds (Table 2). Catfish fed the trout ration had 11% less mesentric fat. Brandt (1979) found that catfish, in open ponds, fed a 50% full-fat soybean ration had a body fat percentage of 2.93. That amount of fat was significantly lower than our average of 5.67%. Some of the difference may be due either to the culture methods or to the heat processing of the full-fat soybeans.

A cost analysis (Table 3) indicated that the Central Arkansas stock fed the commercial trout ration was the better caged catfish/ration combination. Only marginal profit was obtained with the Central Arkansas stock fed the soybean ration. Net losses occurred for the Southeastern stock with both rations. Total cost to produce 0.45 kg of flesh ranged from a low of 47 cents for the Central Arkansas stock fed trout chow to a high of 90 cents for the Southeastern stock fed the full-fat soybean ration.

Overall comparisons, indeed, indicated that the trout ration was better for production of channel catfish in cages. Poor fish performance with the full-fat soybean ration could have been due to improper heat treatment of the raw soybeans. Improper heat treatment of soybeans would prevent adequate fish utilization of essential proteins and vitamins (Brandt, 1979). This may account for the poor performance of both catfish stocks with the full-fat soybean ration in cages as compared to previous feeding trials in open ponds. Further research may aid in establishing better quality control during soybean heat treatment processing. In addition, research needs to be conducted to further define the value of utilizing full-fat soybeans as a primary substitute for animal proteins in channel catfish rations.

The large significant difference in production performance between the two catfish stocks was puzzling. Broussard (1979) noted that wild strains of catfish did not perform as well as more domesticated strains in ponds or cages. The "wilder" the stock, the poorer the production in confined culture. The Southeastern stock appears to be a "wilder" stock than the Central Arkansas stock because of differences in cultural practices, management techniques, and total time of domestication. The Southeastern stock has been maintained by open-pond spawning with minimal selective breeding management. Also, that stock has undergone domestication over a relatively shorter time period. The Central Arkansas stock has been domesticated for a longer period and subjected to intensive cultural management practices (hatchery spawning, selective breeding, etc.).

Table 1. Survival, average net production, F.C.E., and individual gains for two channel catfish stocks fed two rations.

Stock	Ration	Average net production per cage (kg)	F.C.E.	Percent survival	Average fish weight (g) Initial	Harvest	Net gain (g)
Central Arkansas	TC	60.57 a [1]	1.90 a	80 a	28 a	422 a	394 a
	FFS	30.25 b	2.50 b	90 a	28 a	240 b	212 b
Southeastern Arkansas	TC	30.27 c	2.68 c	95 a	28 a	200 c	172 c
	FFS	15.25 d	4.74 d	82 a	28 a	136 d	108 d

[1]Means followed by different letters are significantly different at the 0.05 level.

Table 2. Comparison of marketable qualities between two catfish stocks fed a full-fat soybean and trout ration.

Stock	Ration	Percent body fat	Percent dress out weight
Central Arkansas	TC	4.05 a [1]	60.39 a
	FFS	5.98 b	53.37 a
Southeastern Arkansas	TC	5.44 a	57.87 a
	FFS	7.37 b	54.68 a

[1]Means followed by different letters are significantly different at the 0.05 level.

Table 3. Cost analysis on a per cage basis for two stocks of channel catfish.

Stock	Ration	Feed cost per kg	Fingerling cost	Harvest price per kg	Weight harvested (kg)	Ration cost	Net profit
Central Arkansas	TC	$0.55	$12.00	$1.43	75.09	$71.80	$23.57
	FFS	$0.42	$12.00	$1.43	43.75	$46.94	$ 1.57
Southeastern Arkansas	TC	$0.55	$12.00	$1.43	37.99	$32.02	-$ 3.67
	FFS	$0.42	$12.00	$1.43	17.35	$36.17	-$15.64

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