# Effects of Two Dietary Protein Levels on Body Weight and Composition of Juvenile Blue and Channel Catfish During the Winter

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**ABSTRACT.** Blue catfish (*Ictalurus furcatus*) juveniles (59 g) and channel catfish (*I. punctatus*) juveniles (84 g) were stocked at 24,700 fish/ha into twelve 0.04-ha earthen ponds and fed diets containing either 25 or 35% protein according to a winter feeding schedule. After 189 days, final biomass in ponds stocked with channel catfish was significantly greater ($P < 0.05$) than in ponds stocked with blue catfish, largely reflecting differences in stocking weights. Both species lost weight during the winter period, whether fed 25 or 35% protein diets. At harvest, fat levels were significantly higher and protein levels significantly lower in blue catfish than in channel catfish, despite the blue catfish's smaller size. Channel catfish appear to rely more on fat stores during the winter period than blue catfish. Blue catfish demonstrated no growth advantage over channel catfish during the winter period. *[Article copies available from The Haworth Document Delivery Service: 1-800-342-9678.]*

## *INTRODUCTION*

Although channel catfish (*Ictalurus punctatus*) are the most commonly cultured ictalurid species in the United States, blue catfish (*I. furcatus*)

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possess several traits that have caused increased interest in the commercial production of this species in recent years (Grant and Robinette 1992). Blue catfish have a higher dressout percentage than channel catfish (Huner and Dupree 1984), greater growth uniformity (Brooks et al. 1982), greater resistance to channel catfish virus (Plumb and Chappell 1978), are easier to harvest (Chappell 1979), and may have faster growth during second-year growout to marketable sizes (Tidwell and Mims 1990).

Growth to marketable size (0.5 kg) requires approximately 18 months, so that an overwintering period for juveniles is required. Few studies have compared winter growth of the two species. Dunham and Smitherman (1981) reported no differences when the two species were stocked at low densities and fed a diet containing 45% protein. Grant and Robinette (1992) reported significantly greater second winter growth in channel catfish than in blue catfish when stocked at 8,078 fish/ha and fed a diet containing 25% protein.

It is known that protein level can be reduced in diets for channel catfish without sacrificing growth in winter months (Robinette et al. 1982). However, this has not been evaluated in the blue catfish. Since blue catfish are reported to be more piscivorous in the wild than channel catfish (Huner and Dupree 1984), sufficient dietary protein during winter months could be more important to this species.

This study was conducted to compare first winter growth of juvenile blue and channel catfish and the effects of dietary protein levels on the two species.

## MATERIALS AND METHODS

A 2 × 2 factorial experiment was designed to determine the winter growth of channel and blue catfishes fed diets containing two protein levels. Juvenile channel catfish (84.2 g) and blue catfish (58.6 g) were stocked into twelve 0.04-ha ponds at a rate of 24,700 fish/ha and fed one of two diets containing either 25 or 35% protein (Table 1). Each of the four treatment combinations was replicated in three ponds. Diets were manufactured into sinking pellets by a commercial feed mill (Farmers Feed, Lexington, Kentucky). Winter feeding schedule was based on one described by Dupree and Huner (1984). The study period extended from 20 October 1992 to 27 April 1993. Fish were fed on 63 days during the period, based on the feeding schedule and the presence of ice cover.

Ponds used in this study were approximately 1.5-m deep and were supplied with water from a reservoir filled by rain runoff. Water levels were maintained at a constant depth by periodic additions. Water tempera-

Ξ 1. Ingredients of diets, containing two levels of crude protein, fed to el and blue catfish during the winter.

| | Diet (% protein) | |
|---|---|---|
| ent | 25% | 35% |
| ›al (67% protein) | 11.0 | 15.0 |
| .n meal (44% protein) | 28.0 | 51.9 |
| corn | 45.9 | 18.0 |
| ›r oil | 1.6 | 1.6 |
| ı | 2.5 | 2.5 |
| ılcium phosphate | 1.0 | 1.0 |
| | 10.0 | 10.0 |

supplied the following vitamins and minerals per kg of diet: retinol palmitate (A), 4532 IU; ciferol ($D_3$) 2266 IU; α-tocopherol (E), 75 IU; menadione (K), 11 mg; cyanocobalamin ($B_{12}$), ıscorbic acid (C), 778 mg; folic acid, 2.2 mg, riboflavin ($B_2$), 13.2 mg; pantothenic acid, 35.2 in, 88.0 mg; choline chloride, 516 mg, thiamine ($B_1$), 11 mg; pyridoxine ($B_6$), 11 mg; Zn (as 173 mg; Fe (as $FeSO_4$), 60 mg; Cu (as $CuSO_4$), 7.5 mg; I (as $CaIO_3$), 3.75 mg; Co (as 1.6 mg, Mn (as $MnSO_4$), 180 mg; Al (as $AlK(SO_4)_2$), 1.0 mg; Se (as $Na_2SeO_3$), 0.3 mg; K (as ′4 mg; and Na (as $Na_2PO_4$), 1932 mg.

ıd dissolved oxygen (DO) were monitored in each pond twice daily and 1600) at a depth of 0.5-m using a YSI Model 57 oxygen meter w Springs Instruments, Yellow Springs, Ohio[1]). Mechanical aeration pplied if DO was predicted (by graph) to fall below 5 mg/L during the Ammonia, nitrite, and pH were determined weekly at 1600 hours.

al number and weight of fish in each pond were determined at t. Fifty fish were randomly sampled from each pond and individual-ghed (g) and measured for total length (cm). Whole bodies of three mpled from each pond were homogenized in a blender and analyzed otein, fats, and moisture. Protein was determined by the Kjeldahl d, fat by ether extraction, and moisture was measured by drying in n (95°C until constant weight) (AOAC 1990).

a were analyzed by two-way analysis of variance (ANOVA) using the cal Analysis System (Statistical Analysis Systems 1988) to determine le interactions of species and dietary protein level on growth, pond tion variables, body composition, and survival. All percentage and ata were transformed to arc sin values prior to analysis (Zar 1984).

[1]se of trade or manufacturer's name does not imply endorsement.

## RESULTS AND DISCUSSION

There were no significant differences ($P > 0.05$) in water quality variables among the four treatment combinations. Overall means (±SE) for the study period were morning temperature (6.2±0.1°C), afternoon temperature (7.1±0.2°C), morning dissolved oxygen (12.6±0.4 mg/L), afternoon dissolved oxygen (13.7±0.4°C), pH (8.4±0.1), total ammonia-nitrogen (0.37±0.27 mg/L), and nitrite-nitrogen (0.002±0.001 mg/L). Monthly means for afternoon water temperatures are presented in Figure 1 and are typical for winter conditions in the region (Mims and Clark 1991; Tidwell and Mims 1991).

There were no significant interactions between main effects of species and dietary protein on any measured variable. This indicates that dietary protein level was not of greater importance to blue catfish than to channel catfish during the winter period. Since there were no significant interactions, the influence of species and dietary protein may be considered separately (Dowdy and Weardan 1983).

### *Dietary Protein*

Fish fed both diets lost weight during the winter period. Dietary protein concentration had no significant effect on average individual weight, total production, individual weight change, harvest biomass, or survival. Robinette et al. (1982) found no difference in growth of fingerling channel catfish when fed 25% or 35% protein diets. Effects of dietary protein on winter growth of blue catfish have not been reported. However, reduction of dietary protein concentrations had no significant effect on subclass means of production variables for blue catfish. Webster et al. (1992) reported that increased protein and fish meal levels may be advantageous for rapidly growing blue catfish juveniles in aquaria. These factors do not appear to be advantageous for blue catfish in ponds during the winter period.

### *Species*

Average individual weight and total biomass were significantly greater for channel catfish than for blue catfish at spring harvest. However, this difference was primarily due to differences in initial stocking weights (84 and 56 g, respectively). Channel catfish lost 13% of body weight during the period, while blue catfish lost 5% (Table 2). These

FIGURE 1. Monthly afternoon water temperatures in ponds during the 189-day winter culture period.

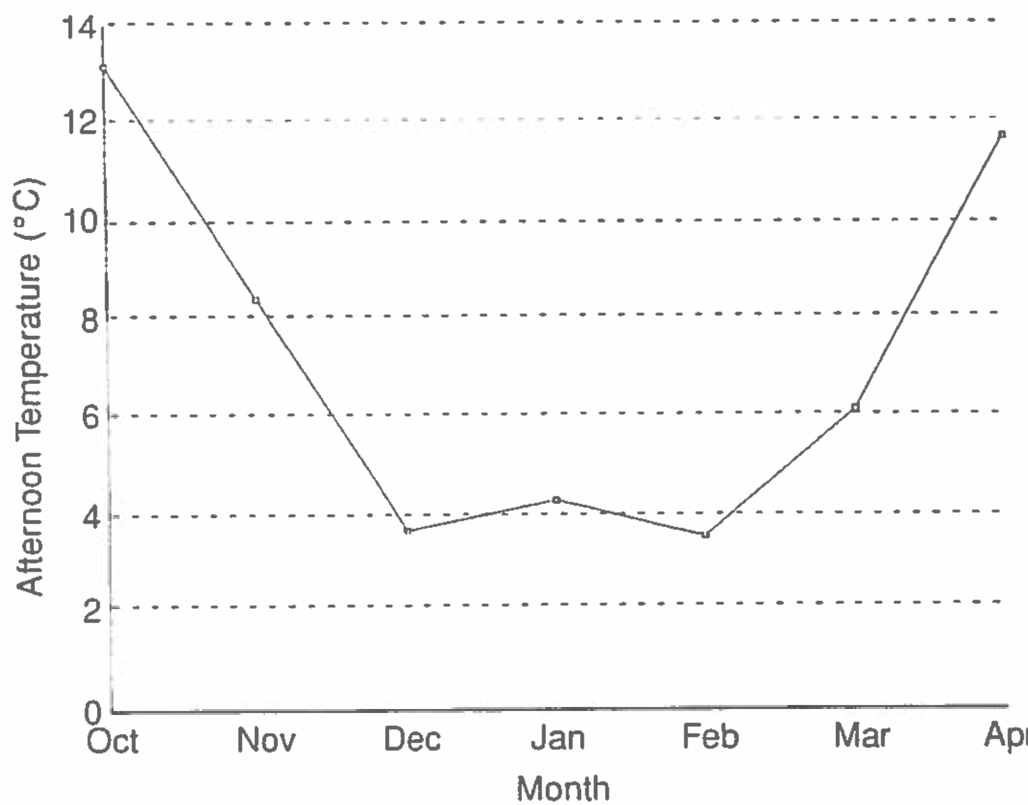

TABLE 2. Main effect means of average weight, average weight change, harvest biomass, and survival of blue and channel catfishes after 189 days of winter culture under two dietary protein regimens. Means ± SE are of six replicate ponds. Main effect means within a column with different letters were significantly different ($P < 0.05$).

| Main effect | Average weight (g) | Individual weight change (%) | Biomass at harvest (kg/ha) | Survival (%) |
|---|---|---|---|---|
| Catfish | | | | |
| Blue | 55.6 ± 2.6y | −4.6 ± 4.1y | 1,399.9 ± 112.8z | 93.5 ± 8.5y |
| Channel | 75.6 ± 3.2y | −12.8 ± 6.1y | 1,830.6 ± 165.0y | 92.3 ± 15.2y |
| Percent-protein | | | | |
| 25% | 64.6 ± 4.3y | −8.5 ± 6.9y | 1,404.9 ± 304.9y | 92.7 ± 8.7y |
| 35% | 66.3 ± 6.1y | −8.8 ± 7.0y | 1,657.1 ± 293.7y | 98.1 ± 7.4y |

differences were not statistically significant. Although studies in the deep south consistently report gains when catfish are fed over the winter (Lovell 1989), overwintering temperatures have a significant effect on the benefit provided by feeding (Reagan and Robinette 1978). Because of the variation imposed by temperatures, optimum feeds and feeding schedules vary at different latitudes (Tidwell and Mims 1991). Studies in Kentucky under temperature conditions similar to these have reported more consistent winter weight loss during the winter for channel catfish than has been reported further south (Tidwell and Mims 1991; Mims and Clark 1991; Goodgame-Tiu et al. 1994). Since sinking diets are used for catfish during the winter, actual consumption of diets could not be directly monitored or observed.

Data reported here are in agreement with Dunham and Smitherman (1981) who found no difference in winter growth of the two species in Alabama. However, these data contrast Goodgame-Tiu et al. (1994) who reported that juvenile blue catfish overwintered in cages in Kentucky lost more weight than channel catfish (26% and 8%, respectively). This difference may be due to the different culture environments used in the two studies (cage vs. pond). Grant and Robinette (1992) reported that channel catfish had higher growth rates than blue catfish during the second winter of growth in Mississippi.

### *Body Composition*

Changes in body composition during the winter period differed between species. Lipid levels remained essentially static in blue catfish between fall stocking and spring harvest (11.7 and 11.0%, respectively). However, lipid levels in channel catfish decreased significantly from 10.2% to 8.0% during the winter period (Table 3). At harvest, lipid levels in blue catfish were significantly higher than lipid levels of channel catfish. Grant and Robinette (1992), using larger fish and having higher winter water temperatures, reported no decreases in lipid levels in either species during the winter period but did report higher lipid levels in blue catfish (12.5%) than in channel catfish (10.3%).

The reduction in lipid concentrations in channel catfish during the winter was at least partially compensated for by increased protein percentage, while moisture level remained static. This is somewhat unusual, in that changes in lipid levels are usually reflected in reciprocal changes in moisture rather than in protein (Tidwell and Robinette 1990). There were no changes in protein and moisture percentages of blue catfish during the winter period. Dietary protein concentration had no significant effect on any body composition variables during the winter period.

In summary, dietary protein concentrations had no effect on growth or body composition of either catfish species. Both fishes lost similar percentages of body weight during the winter period. Depletion of lipid stores appears to account for more of the weight lost in channel catfish than in blue catfish. At water temperatures similar to those reported in this study, a new feeding chart may need to be developed.

TABLE 3. Main effect means of moisture, fat, and protein of channel catfish and blue catfish at stocking and at harvest after 190 days of winter culture under two dietary protein regimens. Means ± SE are of six replicate ponds. Values within a variable within a row (ab) or column within a main effect (yz) followed by different letters are significantly different ($P < 0.05$).

| | Moisture (%) | | Fat (%) | | Protein (%) | |
|---|---|---|---|---|---|---|
| Main effect | Fall stocking | Spring harvest | Fall stocking | Spring harvest | Fall stocking | Spring harvest |
| Species | | | | | | |
| Channel | 71.9 ± 1.5ay | 72.1 ± 0.3ay | 10.2 ± 2.0ay | 8.0 ± 0.3bz | 14.6 ± 0.5ay | 15.6 ± 0.2ay |
| Blue | 70.8 ± 0.4ay | 71.0 ± 0.4ay | 11.7 ± 1.1ay | 11.0 ± 0.5ay | 14.7 ± 0.5ay | 14.2 ± 0.1az |
| Percent-Protein | | | | | | |
| 25% | 71.3 ± 1.1ay | 71.5 ± 0.6ay | 11.0 ± 1.6ay | 9.5 ± 0.6ay | 14.6 ± 0.5ay | 14.8 ± 0.4ay |
| 35% | 71.3 ± 1.1ay | 71.6 ± 0.4ay | 11.0 ± 1.6ay | 9.6 ± 1.2ay | 14.6 ± 0.5ay | 14.9 ± 0.4ay |

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