1-6-2016

The Effects of Dietary Protein-to-Energy Ratio on Juvenile Bluegill (Lepomis macrochirus) Growth with Observations of Sexual Dimorphism

K. Vandeloecht

Gregory A. Dudenhoeffer

Yongfang Zhang

T.R. Omara-Alwala

The Effects of Dietary Protein-to-Energy Ratio on Juvenile Bluegill (*Lepomis macrochirus*) Growth with Observations of Sexual Dimorphism

LINCOLN University 1866

K. Vandeloecht*, G.A. Dudenhoeffer, Y. Zhang, and R.T. Omara-Alwala, Department of Agriculture and Environmental Sciences, Lincoln University, Jefferson City, MO 65101.

Abstract

The Effects of Dietary Protein-to-Energy Ratio on Bluegill (*Lepomis macrochirus*) Juveniles Growth with Observations on Sexual Dimorphism. K. Vandeloecht*, G. Dudenhoeffer, Y. Zhang and T. Omara-Alwala, Department of Agriculture and Environmental Sciences, Lincoln University, Jefferson City, MO 65101. Bluegill is a promising aquaculture species in the Midwest. Males are typically larger than females. However, there is little or no information on nutritional differences between sexes and protein-to-energy ratio. The objective of this study was to characterize the protein-to-energy ratio in juvenile bluegill with observations on gender differences. Bluegill (20 -30g) were fed diets consisting of 35% protein with 14, 16, and 18% lipids and 38% protein with and 12, 14, and 16% lipids. Four replicates of 12 fish each were fed the diets for 16 weeks. Terminal mean body weights, lengths, liver weights, visceral weights, hepatic somatic indices (HSI), and visceral somatic indices (VSI) were recorded. No differences were found in the mean body weights, lengths or visceral weights among diets. Increased liver weights, HSI, and VSI were observed in treatments with 35% protein. The study revealed sexual dimorphism in body weights, lengths, HSI, VSI, and visceral weights. When data were compared by sexes there were more differences and patterns than among diets compared by the overall means. No differences in the body weights and lengths were found among fish fed different diets. Liver characteristics of fish fed the 35% diets could indicate future fish growth problems. There is a need for further investigation of the effect of gender on feeding trials.

Introduction

Bluegill (*Lepomis macrochirus*), is important to the aquaculture industry for use as a feeder, sports and food fish. There is limited research about diets for bluegill. Due to the unavailability of commercial feeds, bluegill producers generally use trout or catfish diets which, cause high body fat deposition or poor growth in bluegill (Masagounder, 2010). Protein is the most expensive component of a finfish diet. Excessive energy can cause excessive fat depositions in bluegill visceral organs (Hayward, 2007). More protein is used for an energy source if there is inadequate energy in the diet. Therefore, appropriate protein-to-energy level in a well-balanced diet is essential for efficient bluegill growth. Most studies indicate bluegill protein requirement above 40% (Twibell, 2003), however our on-going research has indicated adequate growth can occur with 38% dietary protein. Bluegills are sexually dimorphic. Males are generally larger than females (Hayward and Wang, 2006). Little is known about the effect of gender on other growth parameters. The objective of this study was to characterize the protein-to-energy ratio in juvenile bluegill with observations on gender differences within treatments.

Materials and Methods

Diets

- Diets were formulated with 35 and 38% protein and 14, 16, and 18% and 12, 14, and 16% lipids respectively (Table 1)
- Menhaden Fish meal and fish oil were the protein and lipid sources (Table 1)

Experimental Fish and Culture System

- Experimental fish were purchased from Suttle Fish Farm, Laurel, Mississippi
- Initial bluegill weights ranged from 17-29g with a mean of 22.4 ± 3.1 g with no significant differences among treatments
- Experimental tanks (40 gallon, 200L) were plumbed parallel within the recirculating aquaculture system (RAS) containing a sump tank, a bead filter, an in-line ultraviolet sterilizer, and a submerged media biofilter

Experimental Design, Data Collection, and Analysis

- Experimental diets were fed to four replicates of 12 fish each in a completely randomized statistical model design
- Water quality levels were measured weekly and were within normal range. Ammonium levels ranged from 0.05 - 0.11 $mg \cdot L^{-1}$, nitrite levels ranged from 0.002 - 0.025 $mg \cdot L^{-1}$, nitrate levels ranged from 0.002 - 0.025 $mg \cdot L^{-1}$, and pH levels ranged from 8.05 - 8.67
- Water temperature and dissolved oxygen (DO) levels were recorded daily; temperature levels averaged at 26.29 °C ± 1.09 and DO averaged at 7.06 ± 0.49 $mg \cdot L^{-1}$
- Fish were fed three times a day by hand at 0800, 1200, and 1600 h Monday through Saturday. Feed consumption was recorded daily
- Biweekly biomass was obtained
- Individual body weights (bwt), lengths (len), liver, visceral, and roe weights were recorded upon experiment termination at 16 weeks
- Proximate composition of the diets, fish fillets, and visceral were performed using the AOAC 2000 methods
- Feed Conversion Ratio (FCR), Hepatic Somatic Index (HSI), and Visceral Somatic Index (VSI), were calculated
- Data were analyzed by a one way ANOVA (SAS version 9.1). Means were separated by Fisher's Least Significant Difference (LSD) (Steel and Torrie, 1980) at $p < 0.05$

Results

Table 1. Formulation and proximate composition of protein-to-energy diets fed to bluegill.

Diets	1	2	3	4	5	6
Protein:Energy	109.8	116.6	103.8	101.1	95.6	90.7
Protein:Lipid	38:14	38:12	38:16	35:14	35:16	35:18
Formulation (% by weight)						
Fish Meal [a]	57.09	57.09	57.09	52.39	52.39	52.39
Wheat Mids	4.00	4.00	4.00	4.00	4.00	4.00
Dextrin	17.00	16.50	17.50	20.00	20.50	21.00
Fish oil [a]	8.99	6.99	10.99	9.39	11.39	13.39
Cellulose	6.97	9.47	4.47	8.27	5.72	3.27
Constant Ingredients [b]	5.95	5.95	5.95	5.95	5.95	5.95
Proximate composition and energy (DM basis) in mean percent ± SE of triplicate						
Crude Protein (%)	38.39 ± 0.23	37.96 ± 0.21	38.23 ± 0.39	35.04 ± 0.67	35.42 ± 0.48	35.32 ± 0.04
Crude Lipid (%)	13.69 ± 0.04	11.80 ± 0.06	15.64 ± 0.10	13.50 ± 0.07	15.53 ± 0.04	17.34 ± 0.14
Ash (%)	14.23 ± 0.02	14.31 ± 0.04	14.06 ± 0.08	13.11 ± 0.03	13.21 ± 0.18	12.98 ± 0.12
Moisture (%)	5.67 ± 0.11	5.92 ± 0.11	5.74 ± 0.44	6.11 ± 0.06	5.75 ± 0.05	5.87 ± 0.02
Energy (kj/g)	19.76 ± 0.03	20.51 ± 0.08	21.48 ± 0.09	19.59 ± 0.06	20.56 ± 0.00	21.48 ± 0.01

[a] Menhaden source

[b] Constant ingredients: Vitamin Premix (3%), Mineral Premix (0.1%), Ascorbic Acid (0.05%), Carboxymethyl Cellulose (2.0%), Choline Chloride (0.8%)

Figure 1: Mean Body Weights & Lengths

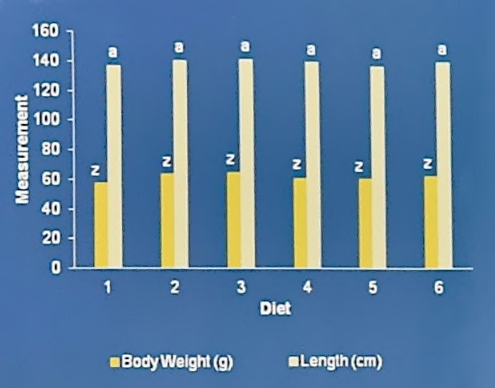


Figure 2: Feed Conversion Ratios (FCR)

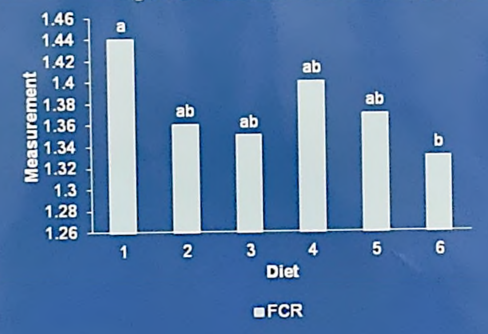


Figure 3: Mean Liver Weights & HSIs

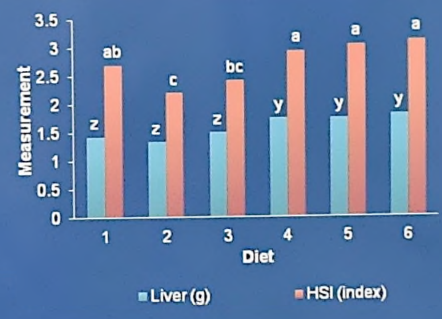


Figure 4: Mean Visceral Weights & VSIs

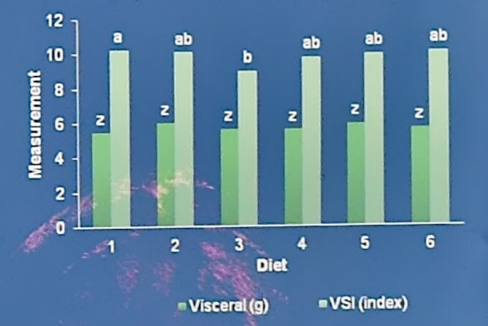
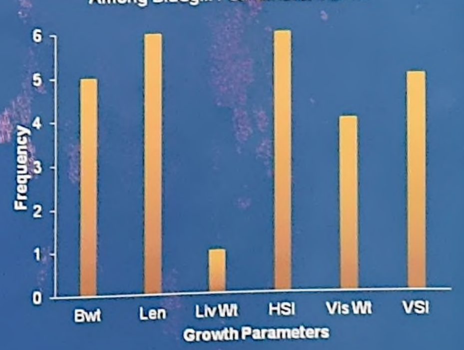


Table 2: Data comparisons by means of both sexes or males [a]

Diets	Mean # of Males per Tank	Body Weight (g)		Length (mm)		HSI		Liver Weight (g)		Visceral Weight (g)		VSI	
		Males & Females	Males	Males & Females	Males	Males & Females	Males	Males & Females	Males	Males & Females	Males	Males & Females	Males
1	5.75	57.5 a	74.8 yz	137 a	148 xy	2.7 ab	2.0 x	1.4 b	1.5x	5.5 a	6.4 z	10.2 a	8.3 z
2	7.00	63.9 a	71.6 yz	140 a	146 xy	2.2 c	2.0 x	1.3 b	1.4x	6.0 a	5.9 z	10.1 ab	8.2 z
3	9.50	65.4 a	71.9 yz	142 a	146 xy	2.4 bc	2.2 xy	1.5 b	1.6xy	5.6 a	6.2 z	9.0 b	8.5 z
4	6.25	61.2 a	79.2 z	140 a	153 z	2.9 a	2.4 zy	1.7 a	2.0z	5.6 a	6.6 z	9.8 ab	8.2 z
5	8.00	61.3 a	70.2 y	138 a	144 x	3.0 a	2.6 z	1.7 a	1.8yz	6.0 a	6.2 z	10.0 ab	8.7 z
6	7.75	63.7 a	76.7 yz	141 a	150 yz	3.1 a	2.5 z	1.8 a	1.9z	5.7 a	7.1 z	10.2 ab	9.1 z

[a] Comparisons were among treatments using both sexes or only the males. Differences are within columns.

Figure 5: Frequency of Gender Differences Among Bluegill Fed Different Diets



Discussion

- No significant difference was found in the growth of the fish among treatments (Fig. 1)
- Significant difference was found in FCR between diets 1 and 6 (Fig. 2)
- There was a significant difference in the liver weights between fish fed the 35% and 38% protein diets (Fig. 3). Differences also occurred in the HSI and VSI (Fig. 3 & 4)
- Significant gender differences existed in bwt, len, HSI, visceral weight, and VSI within all treatments (Fig. 5). In a feeding trial with a limited number of fish such as this study, the sex of the fish is an important consideration
- When only male fish were analyzed, more growth performance differences were found than when both sexes were included in the analysis (Table 2)

Conclusion

- No significant growth differences were seen among the treatments with the protein-to-energy diets used for the study
- Fish fed the 35% protein diets had significantly higher liver weights than fish fed the 38%. A similar trend was present with HSI
- Gender differences within treatments were found in body weight, body length, HSI, visceral weight and VSI

Literature Cited

- Hayward, Robert S., Wang, Han-Ping. 2006. Rearing Male Bluegill Indoors May Be Advantageous for Producing Food-Size Sunfish. Journal of the World Aquaculture Society. Vol, 37, No. 4.
- Hayward, Robert S. 2007. Rapid Determination of Amino Acid Requirements of Lepomis Sunfish. University of Missouri- Columbia.
- Masagounder, Karthik. 2010. Enhancing Bluegill Production Through Least- Cost Diet Development and Novel Rearing Strategies. PhD Thesis, University of Missouri- Columbia.
- Steel, R.G.D., Torri, J.H., 1980. Principles and Procedures of Statistics: A Biometric Approach. McGraw-Hill, New York.
- Twibell, Ronald G. 2003. Evaluation of Experimental and Practical Diets for Bluegill Lepomis macrochirus and Hybrid Bluegill L. cyanellus X L. macrochirus. Journal of the World Aquaculture Society. Vol. 34, No. 4.

Acknowledgements

This project was supported by the USDA/NIFA Evans-Allen Agricultural Research Project MOX-Omara-Alwala-2. We would like to express our gratitude to DSM Nutritional Products Inc. for providing us with choline chloride, vitamin premix, and ascorbic acid, Rick Barrows of the USDA Agriculture Research Service for the mineral premix, and Nutriblend for the fish oil.