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Effects of Soybean Meal Substitution for Fish Meal in Diets of Juvenile Bluegill (Lepomis macrochrius)

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Abstract

❖ *Stuckenschneider, K.A., Allen, A.S. Weckenborg, A.J., A.S., Dudenhoeffer, G.A., Zhang, Y.F., and Omara-Alwala, T.R. Department of Agriculture and Environmental Sciences, Lincoln University, Jefferson City, MO 65101. EFFECTS OF GRADUATED SOYBEAN MEAL SUBSTITUTION FOR FISH MEAL IN DIETS OF JUVENILE BLUEGILL *(Lepomis macrochirus)*. Bluegill has potential for production as a food fish. Feed is 40-60% of total production costs. Few studies have been conducted on bluegill replacing fish meal with soybean meal, which is a less expensive plant protein source. The objective of this experiment was to determine the effect of 25, 50, 75% soybean meal substitution of fish meal protein in juvenile bluegill diets. Treatments consisted of a 38% crude protein control diet, and diets with 25, 50, and 75% of fish meal replaced with soybean meal (SB Sub). All diets were isonitrogenous and isocaloric. A completely randomized block design was used with four replications of each treatment. Twelve fish (~22g) were stocked in indoor water recirculating aquaculture system. Fish were fed to satiation at 0800, 1200, 1600h daily excluding Sunday for 14 weeks. No significant differences (P> 0.05) existed among fish between final weight, percent weight gain, and SGR in control and SB Sub diets. Fish fed 50% SB Sub diets significantly outperformed (P<0.05) fish fed other SB Sub diets. Fish fed 75% SB Sub had lowest final weight, percent weight gain, and feed consumption. This study showed that at least 50% of the fish meal can be replaced with soybean meal without affecting growth.

Introduction

Bluegill (*Lepomis macrochirus*) is important to the aquaculture industry for their use as either a sports, feeder, or a food fish. There are currently more than 400 farmers producing sunfish in the United States (Morris and Clayton, 2009). However, the unavailability of commercial feeds specifically designed for bluegill is limiting production, particularly as a food fish. Commercial catfish and salmonid diets currently in use for bluegill causes low growth or high fat deposits. Limited research has been done in developing a well balanced diet for juvenile bluegills. Most studies suggest a dietary protein of 40 or higher percent (Twibell *et al.*, 2003; Stinefelt *et al.*, 2004). However, our research has shown adequate growth could occur with a 38% dietary fishmeal protein. Feed is 40-60% of total fish production costs (De Silva and Anderson 1995; Brown *et al* 1996). Significant savings are possible by replacing fish meal with soybean meal. There is little information on the inclusion of soybean meal in bluegill diets. The objective of this experiment was to determine the effect of 25, 50, 75% soybean substitution of fish meal protein in juvenile bluegill diets.

Materials and Methods

Experiment Design, Data Collection, and Analysis

❖ Completely randomized design was used with four replicates for each treatment

❖ Treatments consisted of isonitrogenous (38%) and isocaloric (353 kcal/100g) control diet and three diets that replaced 25, 50, 75% of the control diet fish meal with soybean meal (Table 1)

❖ Each experimental units was stocked with 12 bluegill fingerlings (~22 g) and fish were acclimated for a week

❖ Fish were hand fed three times a day to satiation at 0800, 1200, 1600h Monday- Saturday with feed intake recorded daily

❖ Duration of the experiment was 14 weeks

❖ Parameters measured were initial and final body weight, length, biweekly biomass, feed consumption, and visceral and liver weights

❖ Feed conversion ratio (FCR), specific growth rate (SGR), percent weight gain, hepatic somatic index (HSI), and visceral somatic index (VSI) were calculated

❖ Statistical unit was the tank. Data was analyzed by one-way ANOVA (SAS version 9.1). Means were separated by Fisher's Least Significant Difference (LSD) (Steele and Torrie 1980). P< 0.05 was considered significantly different

Experimental Fish and Culture System

❖ Bluegill fingerlings were purchased from Flowers Fish Farm, Dexter, MO

❖ Water recirculating aquaculture system consisted of flat bottom conical tanks (151-L; 40 gal), sump tank, bead filter, and submerged media bio-filter where water residence time ranged from 30 to 45 minutes

❖ Water temperature and dissolved oxygen (DO) were measured daily with a mean and standard deviation of 23.6 ± 0.9°C and 7.4 ± 1.3 mg/L, respectively

❖ Ammonium (NH3-N), Nitrite (NO2-N), and Nitrate (NO3-N) were measured weekly with a mean and standard deviation of 0.4 ± 0.02, 0.005 ± 0.002, and 22.1 ± 7.4 mg/L, respectively

Results

Table 1. Diet Composition

	Control	Soybean Substitution		
Formulation (% by weight)	38% P	25% SB Sub	50% SB Sub	75% SB Sub
Menhaden Fish Meal	**55.60**	**41.70**	**27.80**	**13.90**
Soybean Meal	**0.00**	**17.90**	**35.70**	**53.50**
Wheat Mids	4.00	4.00	4.00	4.00
Dextrin	**17.00**	**15.00**	**8.50**	**2.04**
Menhaden Fish Oil	**7.00**	**6.39**	**7.82**	**9.24**
Vitamin Mix	3.00	3.00	3.00	3.00
Mineral Premix	0.10	0.10	0.10	0.10
Ascorbic Acid	0.05	0.05	0.05	0.05
CMC	2.00	2.00	2.00	2.00
Choline Chloride	0.80	0.80	0.80	0.80
Cellulose	**10.45**	**9.10**	**10.20**	**11.37**
Total:	100.00	100.00	100.00	100.00
Proximate composition (DM basis) in mean percent ± SD of triplicates				
Crude Protein (%)	38.16 ± 0.18	37.95 ± 0.28	38.33 ± 0.81	38.34 ± 0.23
Crude Lipid (%)	13.08 ± 0.17	11.18 ± 0.06	11.50 ± 0.02	11.72 ± 0.14
Crude Ash (%)	12.19 ± 0.05	10.65 ± 0.07	9.15 ± 0.06	7.34 ± 0.14
Moisture (%)	5.89 ± 0.08	4.30 ± 0.18	4.14 ± 0.16	5.46 ± 0.31
Digestible Energy (kcal/100g)	352.50	352.50	352.50	352.50

Figure 1. Initial and Final Weights

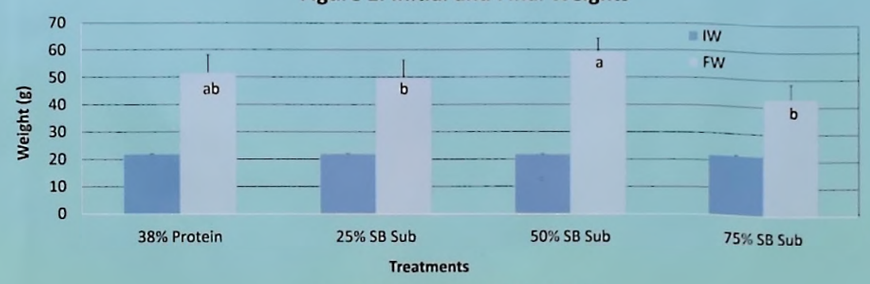


Figure 2. Percent Weight Gain

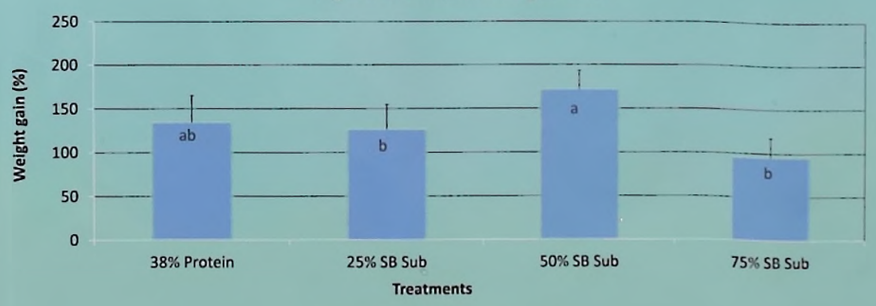


Figure 3. Feed Consumption

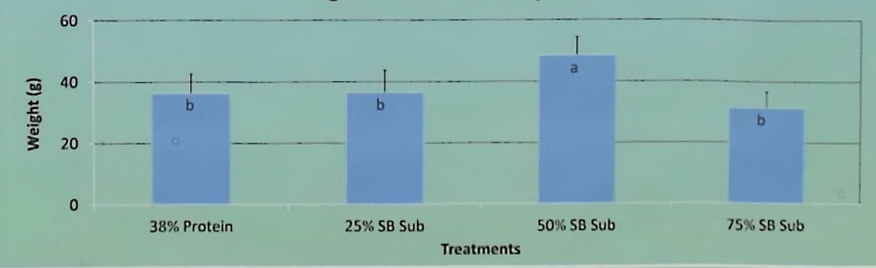


Figure 4. Feed Conversion Ratio

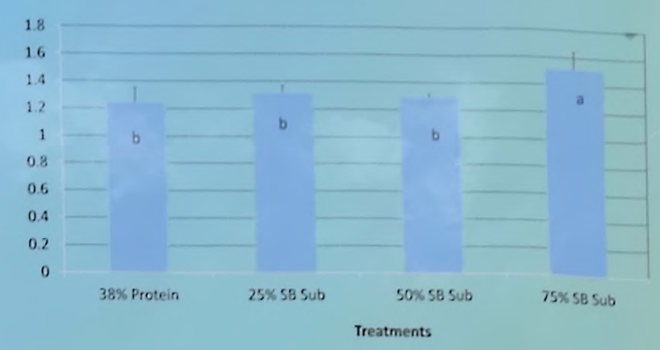


Figure 5. Specific Growth Rate (SGR)

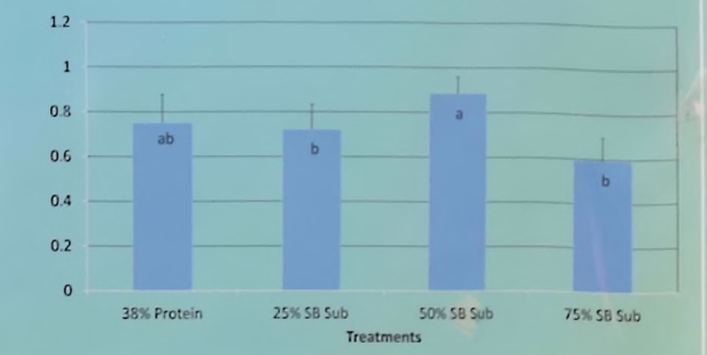


Figure 6. Hepatic Somatic Index (HSI)

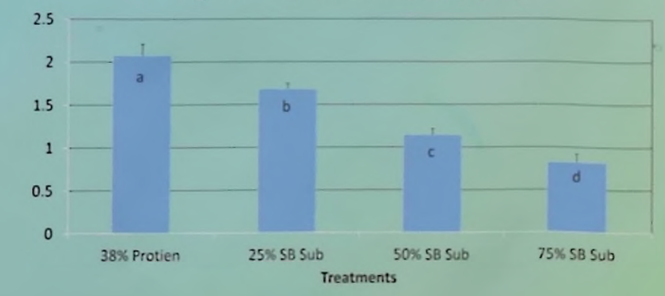
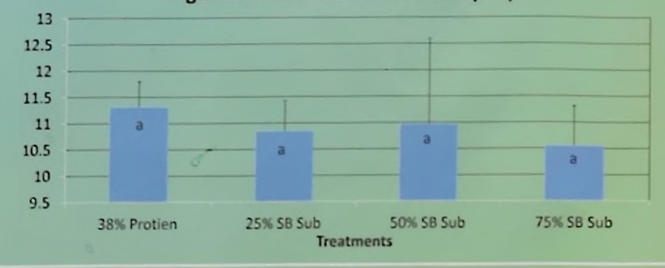


Figure 7. Visceral Somatic Index (VSI)



Discussion

❖ Little difference existed between fish in 38% protein control diet and SB Sub diets
❖ Fish fed 50% SB Sub diets outperformed 25 and 75% SB Sub diets
❖ Fish Fed the 75% SB Sub generally had the poorest performance of all the diets

Conclusion

❖ This study showed that at least 50% of the fish meal could be replaced with soybean meal without affecting growth in juvenile bluegill raised in an indoor water recirculating aquaculture system

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Literature Cited

Brown, P.B., K. Dabrowski, and D.L. Garling. 1996. Nutrition and feeding of yellow perch (Perca Flavescens). Journal of Applied Ichthyology 12; 171-174.

De Silva, S.S. and T.A. Anderson. 1995. Fish nutrition in aquaculture. Chapman & Hall, New York.

Morris, J. E., and R. D. Clayton. "Centrarchid aquaculture." *Centrarchid fishes: diversity, biology, and conservation* (2009): 293-311.

Steele, R.G.D, J.H. Torrie, 1980. Principles and procedures of statistics. A Biometric approach second ed. McGraw-Hill, New York

Stinefelt, B.M., J.C. Eya, K.J. Semmens, and K.P. Blemings. 2004. Effect of Diet and strain on growth and performance in hybrid bluegills. North American Journal of Aquaculture 66: 312-318.

Twibell, R.G., K.A. Wilson, S. Sanders, & P.B. Brown, (2003) Evaluation of experimental and practical diets for bluegill (*Lepomis macrochirus*). J. World Aquac. Soc., 34, 487-495.