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Optimum Dietary Protein Level for Blue Streak Hap, *Labidochromis caeruleus*

Sebahattin Ergün[1,*], Derya Güroy[1], Haluk Tekeşoğlu[1], Betül Güroy[1], İhsan Çelik[1], A. Adem Tekinay[1], Musa Bulut[1]

[1] Canakkale Onsekiz Mart University, Faculty of Fisheries, Department of Aquaculture, Çanakkale 17100, Turkey.

* Corresponding Author: Tel.: +90.286 2180018 - 1570; Fax: +90.286 2180543;
E-mail: sergun@comu.edu.tr

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Abstract

An experiment was designed to determine the optimum dietary protein level of a freshwater ornamental fish, Blue streak hap (*Labidochromis caeruleus*). Four isocaloric fish meal based diets ranging from 30% to 45% in protein were fed to triplicate groups of Blue streak hap for 8 weeks. Fish (initial weight, 0.85 g) were reared in twelve 50 L aquarium with biological filter and controlled temperature (27.5°C), in stocking density of ten fish/aquarium. Results showed that dietary protein level significantly influenced final weight, weight gain and specific growth rate of fish. Maximum growth of fish was observed in the 40% protein diet, although this was not significantly different from the 35% and 45% protein diets (P>0.05). Specific growth rate and feed efficiency increased from 30% to 40% protein, and thereafter decreased for diet 45% protein. There were statistically significantly differences in feed intake among treatments (P<0.05). Fish fed with the highest protein diet had lower percentage daily feed consumption values than those of fish fed with the lowest protein diet. Under the experimental conditions applied, juvenile blue streak hap, *L. Caeruleus,* appear to require more than 35% dietary protein for optimized growth.

Keywords: blue streak hap, *Labidochromis caeruleus*, protein requirements, ornamental fish nutrition, growth.

Sarı Prenses Balığı (*Labidochromis caeruleus*) Yeminde Optimum Protein Oranı

Özet

Bu araştırmada, akvaryum balıklarından sarı prenses (*Labidochromis caeruleus*) balığının yemdeki optimum protein ihtiyacı incelenmiştir. Üç tekerrürlü olarak yürütülen çalışmada, sarı prenses yavruları, protein oranı %30 ile %45 arasında değişen dört farklı eşit enerji içeriğine sahip yemlerle sekiz hafta süreyle beslenmiştir. Yavru balıklar (0,85 g), su sıcaklığı 27,5°C olan biyolojik filtreli ve 50 L su hacimli 12 adet akvaryuma stok yoğunluğu 10 adet balık/akvaryum olacak şekilde konmuştur. Deneme sonunda elde edilen veriler, yemdeki protein oranının balıkların deneme sonu ağırlığını, ağırlık artışını, spesifik büyüme oranını ve yemden yararlanmayı önemli derecede etkilediğini göstermiştir. Gruplar içerisinde en iyi büyüme %40 protein içeren yemde görülmekle beraber, %35 ve %45 proteinli yemlerle beslenen balıklarla bu grup arasında istatistiksel olarak önemli bir fark yoktur (P>0,05). Spesifik büyüme ve yemden yararlanma oranları %30 proteinden %40 proteinli gruplara doğru artmış ve sonra %45 proteinde düşmüştür. Grupların yem tüketimleri arasında istatistiksel olarak önemli farklılıklar bulunmuştur (P<0,05). En yüksek protein içeriğine sahip yem ile beslenen balıkların günlük yem tüketim yüzdesi, en düşük protein içeriğine sahip yem ile beslenenlere göre daha düşük bulunmuştur. Bu deneme koşullarında, sarı prensesin optimum büyümesi için %35'den daha yüksek oranda proteine ihtiyaç duyduğu görülmüştür.

Anahtar Kelimeler: sarı prenses, *Labidochromis caeruleus*, protein ihtiyacı, süs balığı beslenmesi, büyüme.

Introduction

The Blue streak hap, *Labidochromis caeruleus*, is a freshwater perciform fish, a cichlid and called the Electric Yellow, Lemon Yellow Lab, the Blue Streak Hap, the Electric Yellow African or Yellow Prince. Blue streak hap is a bright yellow freshwater cichlid and one of the most commercially valuable aquarium fish species.

Well balanced and suitable diets are one key biological component for support good growth and health of fish. Nutritional studies have been performed primarily on aquaculture species; nutrient requirements have been reviewed and compiled by the

National Research Council (NRC, 1993). In fish feeds, protein is a major component because it provides the essential and nonessential amino acids to synthesize body protein and in part provides energy for maintenance. Protein requirements of the most ornamental fish range between 30% and 55% (Sales and Janssens, 2003) depending on fish species, protein quality, dietary non-protein energy level and size. Increasing protein level in diets can generally lead to improved fish production, especially for carnivorous fish. However, excessive dietary protein level is not economical for fish culture because it is responsible for a large part of the feed cost and also primary source of nitrogen waste in fish culture.

There is still paucity in research on the nutritional requirements and feeds for ornamental fish despite their economic importance in comparison with those of food fish (Shim and Chua, 1986; Sales and Janssens, 2003). Currently, there is no information on the dietary requirements of the Blue streak hap. The present study was conducted to investigate the effects of dietary protein levels on growth performance and feed utilization of Blue streak hap, *Labidochromis caeruleus*, in a recycled water system.

Materials and Methods

Experimental Fish and Rearing Condition

Labidochromis caeruleus, which were obtained from a local commercial aquarium (Istanbul / Turkey), were transported to Aquarium Unit of Fisheries Faculty, Çanakkale Onsekiz Mart University, Turkey. Prior to the start of the feeding trial, fish were transferred to a 100 L aquarium and fed a commercial diet (35% protein; 10% fat) for 2 weeks to adjust to the experimental conditions. After the conditioning period, ten fish weighing 0.85 g were randomly stocked into the twelve glass aquariums of 50 L (holding capacity: 72 L) (30 cm x 60 cm x 40 cm deep) each filled with dechlorinated tap water. There were three replicates per treatment.

The total volume of the system was 1020 L and included twelve 50 L aquariums, a 120 L sump and a 300 L biofilter containing bioballs. Two hundred liters (~20%) of makeup water was added daily. The water turnover rate in each tank was 50 min. Dissolved oxygen levels and water temperature was monitored with a portable oxygen meter (WTW model, OXI 196) daily, averaged 7.4 mg L^{-1} and 27.4°C, respectively. Fish were fed to apparent satiation three times a day at 08:30, 12:30 and 16:30 hours for 8 weeks. Records were kept of daily feed consumption. Light was supplied by overhead fluorescent bulbs. Photoperiod was set to a 9:15 light/dark cycle throughout the study. Fish were weighed (live weight, following removal of excess water) individually in a tared volume of water at the beginning of the experiment and every 2 weeks until the end of the experiment. During the experiment, feces and pellet residues were removed by siphoning on a daily basis.

Experimental Diets

Four isocaloric experimental diets in which fish meal were used as the main protein source were prepared to contain different protein levels of 30%, 35%, 40%, and 45% (Table 1). The pre-weighed dry ingredients were carefully mixed using a laboratory food mixer with separate addition of the oil and vitamin/mineral premix. The mixtures were primed with water to yield a suitable mash. Moist diets were made into 1 mm pellet size and dried at 40°C in a fan assisted drying cabinet.

Chemical Analysis

Experimental diet and feedstuffs were analyzed for proximate composition according to AOAC (1990). Dry matter was determined after drying at 105°C until a constant weight was obtained. Ash content was measured by incineration in a muffle furnace at 525°C for 12 h. Crude protein was analyzed by the Kjeldahl method after acid digestion using Gerhardt system. Lipid extractions were undertaken by petroleum ether extraction in a Soxhlet extraction system.

Evaluation of Growth Parameters

Growth performance of Blue streak hap fed with the different protein level diets was evaluated by calculating mean weight gain (WG), specific growth rate (SGR), feed conversion rate (FCR), feed efficiency (FE), daily feed intake (DFI), daily protein intake (DPI) and protein efficiency ratio (PER).

WG (%) = [(final weight (g) – initial weight (g)) / initial weight (g)] x 100

SGR(% day^{-1}) = [(ln final weight(g) – ln initial weight (g))/days of the expr.] x100

FCR = feed intake (g) / weight gain (g)

FE = wet weight gain (g) / feed intake (g)

DFI = (daily feed consumed / body weight) x 100

DEI = daily feed intake (g) x gross energy in feed (Kcal)

DPI = daily feed intake (g) x crude protein in feed (%)

PER = wet weight gain (g) / dietary crude protein intake (g)

Statistical Analysis

The data were subjected to analysis of variance (ANOVA). When a significant difference was found among treatments, Duncan's multiple range test was performed (Zar, 2001). Statistical analysis was performed using the SPSS 7.0 version for Windows and results were treated statistically significant at the 5% level.

Results

Dissolved oxygen levels and water temperature ranged from 7.0 to 8.1 mg L^{-1} and 26 to 28°C, respectively throughout the feeding trial. Experimental diets were formulated using conventional feed ingredients (Table 1). Proximate analysis of the diets (Table 1) showed that the intended protein levels of 30-45% were obtained.

During feeding trials fish readily accepted and consumed experimental diets and were satiated within 10 to 15 min of each feeding period. The fish easily adapted to the culture systems and had excellent survival 100%. Growth performance and feed utilization of *Labidochromis caeruleus* fed the different protein level diets are shown Table 2.

Growth responses and feed utilization of fish fed the experimental diets were influenced by the levels of protein. At the end of the feeding trial, higher growth rates were attained fish fed at higher protein diets (Table 2, Figure 1 and 2). However, the highest dietary protein level resulted in reduced performance.

The highest growth performances and feed utilization were found by fish fed 40% protein in diet. Fish fed with 35% and 45% protein diet had a higher weight gain and specific growth rate than fish fed with 30% protein diets (P>0.05), but these differences were not highly significant. After the fourth week, fish were not fed for five days due to a pump failure. This incident affected the growth rate in all replicates (Figure 1). Overall, fish fed with 30% protein had significantly higher FCR compared to the other dietary treatments (P<0.05). Daily feed intake (DFI) decreased as the protein content of diet increased. Daily protein intake (DPI), on the contrary of the DFI, increased with protein level of diet (Table 2). Over the course of the experiment, survival was 100% and hence not affected by dietary treatment. A polynomial

Table 1. Formulation and proximate composition of experimental diets (%)

	Experimental Diets			
	30%	35%	40%	45%
Dietary composition				
Anchovy fish meal [a]	28.0	36.5	44.5	53.0
Wheat flour	59.1	51.3	44.0	36.3
Corn gluten	4.0	4.0	4.0	4.0
Fish (Anchovy) Oil	6.9	6.2	5.5	4.7
Vit-Min Premix [b]	2.0	2.0	2.0	2.0
Proximate Analyses				
Moisture	8.0	8.2	7.9	7.9
Crude protein	30.1	34.9	39.8	45.1
Crude oil	10.0	10.1	10.0	10.0
Crude ash	4.3	5.1	5.8	6.6
Gross energy (kJ/g)[c]	19.1	18.8	18.9	18.9
Protein/energy ratio	15.76	18.56	21.06	23.86

[a] Anchovy meal, Sibal Fish Feed and Fish Meal Company, Sinop, Turkey.
[b] Added to supply in excess of vitamin and mineral requirements for salmonids (NRC, 1993).
[c] Energy values are estimated based on 23.6 kJ/g for protein, 39.5 kJ/g for lipid and 17 kJ/g for carbohydrate sources.

Table 2. Growth performance and feed utilization efficiency of *Labidochromis caeruleus*

Diet	30%	35%	40%	45%
Initial Weight (g)	0.86±0.045	0.85±0.043	0.84±0.060	0.84±0.073
Final Weight (g)	2.18±0.066^{a}	2.34±0.054^{ab}	2.49±0.197^{b}	2.28±0.047^{ab}
Weight Gain (%)	152.57±7.568^{a}	175.94±12.329^{ab}	196.21±22.125^{b}	171.33±5.914^{ab}
SGR (%)	1.54±0.049^{a}	1.69±0.072^{ab}	1.81±0,103^{b}	1.66±0.021^{ab}
Survival (%)	100	100	100	100
FCR	2.36±0.094^{a}	2.07±0.104^{b}	1.97±0.044^{b}	2.02±0.031^{b}
Feed Efficiency	0.42±0.017^{a}	0.48±0.024^{ab}	0.51±0.012^{b}	0.49±0.008^{b}
Daily Feed Intake (%)	1.70±0.025^{a}	1.64±0.103^{ab}	1.63±0.194^{b}	1.56±0.052^{c}
Daily Protein Int. (g/fish)	0.93±0.008^{a}	1.19±0.023^{b}	1.29±0.109^{c}	1.31±0.021^{c}
Protein Efficiency Rate	1.41±0.058^{a}	1.25±0.083^{b}	1.27±0.012^{b}	1.09±0.017^{c}
Daily En. Int.(Kcal/fish)	0.99±0.006^{a}	0.99±0.020^{a}	1.06±0.037^{b}	0.96±0.012^{a}

Data represent the mean of three replicates. Values on the same line and different superscripts are significantly different (P<0.05).

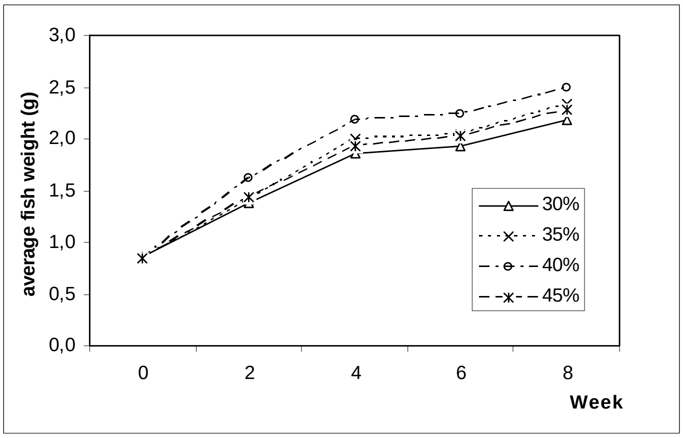

Figure 1. Growth response of *Labidochromis caeruleus* fed with diets containing various levels of protein for 8 weeks. Values are the mean of triplicate groups of fish.

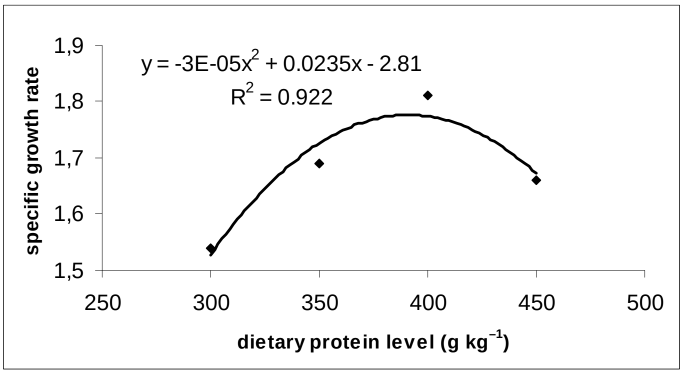

Figure 2. Effect of dietary protein level on the weight gain of juvenile *Labidochromis caeruleus.*

regression equation ($y = -0.00003x^2 + 0.0235x – 2.81$, $r^2 = 0.922$) was fitted to describe the effect of dietary protein levels on the SGR of *L caeruleus* juveniles and the trend is depicted in Figure 2.

Discussion

The present study demonstrated that the dietary protein level significantly influenced growth performance and feed utilization of the Blue streak hap, *Labidochromis caeruleus*. From the growth performance data and the polynomial regression analysis it is observed that the best growth was achieved at 40% dietary protein level. Poorest growth (weight gain %, SGR) and feed conversion rate were recorded for the lowest dietary protein (30%) level in diet.

The protein requirement values for optimized growth of body weight that we obtained for Blue streak hap in the present study was similar to those for omnivorous ornamental fish such as guppy (30-40%) (*P. reticulata*) (Shim and Chua, 1986), tin foil barb (42%) (*Barbedous altus*) (Elengovan and Shim, 1997), redhead chchlid (41%) (*Cichlasoma synspilum*) (Olvera-Novoa *et al*., 1996), *Pangasius pangasius* fingerlings (35%) (Debnath *et al*., 2005) and freshwater angelfish fry (34%) (Zuanon *et al*., 2006). Blue streak hap also appeared to have higher protein requirements than other ornamental omnivorous fishes such as goldfish (29%) (*Carassius auratus*) (Lochmann and Phillips, 1994), dwarf gourami (25%) (*Colisa lalia*) (Shim *et al*., 1989) but lower than carnivorous fishes such as swordtails (45%) (*Xiphorus helleri*) (Kruger *et al*., 2001), discus (45%) (*Symphysodon* spp.) (Chong *et al*., 2000). Hence, the similarity of the protein requirement of Blue streak hap and those of the above mentioned fish species show that blue streak hap can be accepted as omnivorous fish species.

Increases in dietary protein level have often been associated with higher growth rates in many species. In the present study, however, the best growth and FCR for Blue streak hap were obtained using the diet containing 40% protein. SGR and feed efficiency increased from 30% to 40% dietary protein, and thereafter decreased for diet containing 45% protein. Similarly, plateaus or decreases in weight gain of fish fed diets containing protein levels above the dietary requirement have been observed in several other fish species (Siddiqui *et al*., 1988; El-Sayed and Teshima, 1992; Chong *et al*., 2000; Kim *et al*., 2004). It has been suggested that the reduction of growth from excessive protein may result when inadequate nonprotein energy is available to deaminate and excrete excess absorbed amino acids (Jauncey, 1982).

In this study, fish were fed to apparent satiation. At the end of the experiment, results of the present study data showed that daily feed intake decreased with increasing dietary protein level. Similarly, other authors reported an increase in protein requirement with decreasing feeding levels for other several fish species (Martinez-Palacios *et al*., 1996; Chong *et al*., 2000; Kim and Lall, 2001).

Feed conversion rates (FCR) ranged from 1.97 to 2.36, varying inversely with observed growth rate in the study. FCR was comparable to that freshwater angel fish (a freshwater cichlid) (2.09-2.58) (Zuanon *et al*., 2006) and would perform even better than another freshwater cichlid, discus (2.2-3.8) (Chong *et al*., 2000) and relatively high compared to the values observed for farm-raised food fish (De Silva and Anderson, 1995). In considering results of growth, specific growth rate and feed efficiency of feed, optimum dietary protein level for blue streak hap, *Labidochromis caeruleus*, seemed to be require more than 35% dietary protein level. Since the actual dietary protein requirement of fish is also affected by factors such as protein quality, levels of lipid and digestibility, further studies considering these factors will be needed for more precise determination.

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