Egyptian Journal for Aquaculture
P-ISSN: 2090-7877
E-ISSN: 2636-3984
www.eja.journals.ekb.eg
Khattaby, A.A.; 2021; 11 (1):01-17
DOI: 10.21608/eja.2021.64899.1045

Effect of varying levels of dietary protein and stocking density on, performance and feed utilization of Pangasius Catfish (*Pangasius hypophthalmus*) fingerlings

Abd El-Rahman Ahmed Khattaby

Fish production and Aquaculture systems department; Central laboratory for Aquaculture Research; ARC; Egypt

* Corresponding author: a.a.khattaby@gmail.com

Received: Dec. 8, 2020; Accepted: Jan.22, 2021 published: 2021 Vol.11 (1):01-17

Abstract

A feeding trial for 56 days was conducted to investigate the optimum dietary protein and stocking density that could give the maximum growth performance of Pangasius catfish, *Pangasius hypophthalmus*. Twenty-seven tanks (150 Liter) were used for random distribution of Pangasius fingerlings (5.5±0.2 g) at three stocking densities; 10, 15, and 20 fish/tank. Fish of each density fed either formulated diet of 30, 35, and 40% crude protein (CP). Pangas fingerlings were fed one of the tested diets up to apparent satiety twice a day at 09:00 and 14:00 h. The recorded fluctuation of water parameters was within the normal range such as 27–29°C water temperature, 5.6–6.8mg/l dissolved oxygen, 7.3–7.7pH, and 0.7–1.40 mg/l total ammonia. Obtained data showed that the final body weight, weight gain, weight gain %, specific growth rate (SGR) were significantly affected by protein level and conversely affected by stocking density. The best performance and survival recorded at diet containing 35and 40% protein at the lowest stocking density, while the poorest growth was retrieved with 30%protein at high density (20 fish/tank). Feed utilization parameters were in the same line with the protein level and stocking density effect. The best feed conversion ratio FCR, 1.57±0.06 and 1.53±0.03 was gained with 35% and 40%protein respectively at10 stocking density. Correspondingly, the highest values of PER and PPV were obtained at low density with 35 and 40% CP. No significant differences were recorded in lipid and ash contents in the fish body fed diets of different protein levels at varied stocking densities. Nevertheless, moisture and body protein content were positively affected by dietary protein levels. The results revealed that fish fed diet containing 35% protein with stocking density levels of 10 fish/ 150 L would be suitable for the optimum growth of Pangasius catfish, *P. hypophthalmus* fingerlings.

Keywords: Dietary protein, stocking density levels, Pangasius catfish, *Pangasius hypophthalmus*, growth, feed utilization, whole body composition.

Introduction

Pangasius, a well-known catfish, is one of the major fish species in the Mekong River and regarded as one of the largest and most important inland fishery resources in the world. It is having fast growth, versatile habits, and hardiness, so the fish farmers increase their production volume from pangasius, among farmed fish species, *P. hypophthalmus* is mainly produced in Asian countries such as Bangladesh, Vietnam, Malaysia, Indonesia, Laos, Cambodia, and China. Vietnam is the largest Pangas-producing country (Phan *et al*., 2009). Currently, Pangasius fillets have been exported to over 80 countries worldwide including Netherlands, Germany, and United States, which demand mainly frozen fillets without skin and bone (Phan *et al*., 2009 & Karl *et al.*, 2010). In 2011, striped catfish has ranked the sixth favorite fish species in the United States (FAO. 2012) *Pangasius hypophthalmus* is an omnivorous, ~~a~~ freshwater fish that lives in most countries of Southeast Asia. Currently, the lack of good specially formulated feed has reduced the spread of their culturing and made pangasius farmers resort to using chicken viscera, vegetables, and trash fish as an alternative feed to feed them. Pangasius fish cannot reproduce in ponds naturally, and fingerlings are produced by local hatcheries through the artificial spawning process, and therefore they are considered ~~a~~ low-risk fish in aquaculture. (Hung *et al*., 2001; Chattopadhyay *et al*., 2002). Some unofficial articles referred to the entry of pangasius fish to Egypt as an ornamental fish, through some amateurs, and some attempts to artificially hatch them were successful, then they began to enter commercial fish farming as one of the freshwater fish baskets at the beginning of 2018.

It is known that dietary manipulation directly affects the growth performance and chemical composition of fish (Shearer, 2000). Thus, the inclusion of protein in diets may not only improve the growth and nutritional status, it is a major factor affecting growth performance of fish and also an important source of energy. It has a tremendous effect on the cost of feed (Miller *et al*., 2005) as its cost is far higher than lipids and carbohydrates (Lovell 1989). The increase of protein level in the diet improves fish growth but proportionally increases feed cost. Dietary protein is the most expensive macronutrient in fish diets (Ahmad, 2008). Also, care must be taken that the quantities of protein in the diet are balanced enough to support growth and not exceed the need for fish so as not to be wasted and cause the costs of the diet to rise unnecessarily. This has a basis, as in the case of carnivorous fish like salmons, optimal growth is achieved when about half the dietary energy is provided by proteins, while in other species such as tilapia, cyprinids, and some ictalurids, the excellent growth rate can be achived achieved using lower dietary protein levels (Jobling 1994). Dietary protein and energy requirements of catfishes have been widely examined (Salhi *et al.*, 2004; Ali and Jauncey, 2005; Adewolu and Benfey, 2009). Hung *et al.* (2004) and Phumee *et al*. (2009) evaluated the effect of dietary protein levels on growth and feed utilization of Pangasius catfish, *P. hypophthalmus*.

Stocking density is an important factor for the production of all fishes as well as *P. hypophthalmus.* There are several kinds of literatures on the culture of fish with different commercial fish species conducted in different parts of the world, but no information is available on the optimum stocking density on the culture of *P. hypophthalmus*. Recently, Pangasius catfish, *P. hypophthalmus* was introduced to the aquaculture industry in Egypt. Therefore, the present study was conducted to determining the optimal dietary protein and stocking density levels that could produce optimum growth performance of Pangasius catfish, *P. hypophthalmus* fingerlings under the Egyptian conditions, which is still essential to develop formulated diets for its commercial farming.

Materials and methods

Experimental design and dietary treatments

Three experimental diets were formulated to containing three protein levels 30, 35, and 40% CP with three stocking density levels (10, 15, and 20 fish/150L). The nine dietary treatments were designated as, 30/10, 30/15, 30/20, 35/10, 35/15, 35/20, 40/10, 40/15, and 40/20, protein/ stocking density levels accordingly. Ingredients, nutrient contents of the experimental diets, and proximate composition of all dietary treatments are presented in Table (1).

Dietary formulation and proximate composition of the experimental diets are shown in Table 2. The dry ingredients of each diet were thoroughly mixed, and 100 ml of water was added per kg diet. Afterwards, the mixture (ingredients and water) was blended using a kitchen blender to make a paste of each diet. Pelleting of each diet was carried out by passing the blended mixture through a laboratory pellet machine with a 1mm-diameter diet. The pellets were dried in a drying oven for 24h at 85°C and stored in plastic bags in a deep freezer at −2°C until use.

Table 1. Ingredient and proximate composition of the experimental diets (on dry matter basis).

Ingredients	30% protein	35% protein	40% protein
Fish meal	8.5	10.4	13
Soy bean meal	32.0	36.2	39.5
Ground gluten meal	13.0	17.0	20.0
Ground corn	16.0	6.80	0.3
Dextrin	14.1	14.1	14.1
Cod fish oil	5.25	5.07	4.49
Corn oil	4.42	4.6	4.61
Vitamins premix[1]	1.5	1.5	1.5
Mineral premix[2]	1.5	1.5	1.5
$CaHPO_4$	1.0	1.0	1.0
α- cellulose	2.73	1.83	0.0
Total	100	100	100
Proximate chemical analysis (%)			
Dry matter	92.36	92.55	92.49
Crude protein	30.32	35.20	40.06
Ether extract	12.10	12.14	12.02
Ash	4.86	4.56	4.10
Fiber	4.12	3.27	2.77
NFE[3]	48.60	44.83	41.05
GE (Kcal/ kg)[4]	484.96	497.37	508.10
P/E ratio	62.52	70.77	78.84

1- Vitamin premix (per kg of premix): thiamine, 2.5 g; riboflavin, 2.5 g; pyridoxine, 2.0 g; inositol, 100.0 g; biotin, 0.3 g; pantothenic acid, 100.0 g; folic acid, 0.75 g; para-aminobenzoic acid, 2.5 g; choline, 200.0 g; nicotinic acid, 10.0 g; cyanocobalamine, 0.005 g; a-tocopherol acetate, 20.1 g; menadione, 2.0 g; retinol palmitate, 100,000 IU; cholecalciferol, 500,000 IU.

2- Mineral premix (g/kg of premix): $CaHPO_4.2H_2O$, 727.2; $MgCO_4.7H_2O$, 127.5; KCl 50.0; NaCl, 60.0; $FeC_6H_5O_7.3H_2O$, 25.0; $ZnCO_3$, 5.5; $MnCl_2.4H_2O$, 2.5; $Cu(OAc)_2.H_2O$, 0.785; $CoCl_3.6H_2O$, 0.477; $CaIO_3.6H_2O$, 0.295; $CrCl_3.6H_2O$, 0.128; $AlCl_3.6H_2O$, 0.54; $Na2SeO_3$, 0.03.

3- Nitrogen-Free Extract (calculated by difference) = 100 – (protein% + lipid% + ash% + fiber%).

4- Gross energy (GE) was calculated from NRC, (1993) as 5.65, 9.45, and 4.1 kcal/g for protein, lipid, and carbohydrates, respectively.

Fish and experimental management

Pangasius catfish, *P. hypophthalmus* fry (5.5±0.2 g) were purchased from a commercial hatchery in Kafr El Sheikh, Egypt, and transported to the Central Laboratory for Aquaculture Research, Abbassa, Abu Hammad, Egypt. Fish were reared in an aerated fiber tank and acclimated to laboratory conditions for 2 weeks where they were fed at a commercial diet containing 30% crude protein (CP). Fifty fish were sacrificed to provide an estimate of initial whole-body chemical composition. After the acclimatization, fish were distributed at a rate of 10, 15, and 20 fish per150-L fiber tank. Each tank was supplied with well-aerated water. Three-quarters of the fiber tank's water was siphoned every day for removing the excretory products and refilled with well-aerated tap-water. Fish were reared under a photoperiod of approximately 12/12 h light/dark cycle. Fish were hand-fed the assigned experimental diet up to apparent satiation twice daily at 09:00 and 14:00 h for 56 days.

Water quality parameters

The tanks were supplied with air blowers continuously aerated. About 10% of the water tank was exchanged daily for waste gets rid and totally with freshwater (dechlorinated tap water) biweekly at 15 cm depth from each tank. Dissolved oxygen and temperature were measured on-site using an oxygen meter (YSI, model 58; Yellow Spring Instrument Co., Yellow Spring, Ohio, USA). Unionized ammonia was measured using a HACH kit (HACH Co., Loveland, Colorado, USA). The pH degree was measured using a pH meter (Fisher Scientific, Denver, Colorado, USA).

Evaluation of growth performance and feed utilization efficiency

Growth performance and feed utilization including weight gain (WG, g), percent weight gain (%WG), specific growth rate (SGR, %/day), feed conversion ratio (FCR) protein efficiency ratio (PER), apparent protein utilization (APU %) and energy utilization (EU %) were determined as follow:

Weight gain = W2 – W1;

Relative body weight gain (%) = 100 (W2 – W1) / W1;

Specific growth rate (SGR; %g/day) = 100 (Ln W2 - Ln W1) / T;

Where W1 and W2 are the initial and final fish weight (g) and T is feeding trial period in days;

Feed intake (FI) = total feed intake per tank / number of fish;

Feed conversion ratio (FCR) = feed intake (g) /body weight gain (g);

Protein intake (PI) = feed intake (g) x percent protein in the diet;

Protein efficiency ratio (PER) = weight gain (g)/ total protein intake;

Apparent protein utilization (APU; %) = 100 [protein gain in fish (g) / protein intake in diet (g)];

Energy utilization (EU; %) = 100 [Energy gain in fish (g) / energy intake in diet (g)].

Fish survival (%) = 100 (final number of fish / initial number of fish).

Proximate analysis of diet and fish

Randomly five fish were chosen from each tank (15 fish per treatment) at the end of the feeding trial and exposed to the chemical composition of the whole fish body. Moisture, total protein, lipid, and ash contents were all determined by Standard Association of Official Analytical Chemist (NRC, 1993) methodology. Moisture content was estimated by drying samples in an oven at 85°C until a constant weight was achieved. Nitrogen content was measured with a micro-Kjeldahl apparatus, and crude protein was estimated by multiplying total nitrogen content by 6.25. Total lipid content was determined by using ether extraction for 16 h, and ash was determined by combusting samples in a muffle furnace at 550° C for 6 h. The crude fiber was estimated according to the method of Goering and van Soest, (1970). Gross energy was calculated according to the method of the National Research Council, (1993).

Statistical analysis

Results are presented as mean ± SE of three replicates. Mean values for all monitored parameters were analyzed by one and two-way ANOVA to test the effects of dietary protein and lipid. Differences for all analyses were considered significant at $P < 0.05$ when compared by Duncan's multiple range tests according to Snedecor and Cochran, (1981). All statistical analyses were carried out using SPSS software SPSS, Version 20.0.

Results and discussion

The water samples were collected for analysis before changing water. Water quality parameters were recorded throughout the study period and were found within the optimal ranges to fish culture. The ranges of water temperature, dissolved oxygen, pH, and total ammonia were 27–29°C, 5.6–6.8mg/l, 7.3–7.7, and 0.7–1.40 mg/l, respectively**.** These results are almost similar to the findings of previous researchers (Uddin 2002; Akter *et al*. 2009; Ahmed *et al*. 2009; Abd El- Naby, 2019). During this trial

The results in table 2, confirmed that the dietary protein levels and stocking densities ($P < 0.05$), and there was a significant interaction between protein different levels and stocking densities influenced growth performance and nutrient utilization in *P. hypophthalmus* fingerlings. The protein requirements of fish have been reported to vary with species, size or age,

Table 2: Growth performances parameters of Pangasius catfish, *P. hypophthalmus* fingerlings fed experimental diets containing different protein and stocking density levels for 56 days.

Variable	IBW (g)	FBW (g)	BWG (g)	RBWG (g)	SGR (%g/day)
Protein level, % (PL)					
PL_1 30%	5.56±0.01	20.55±0.38b	14.99±0.38b	269.68±6.97b	2.33±0.03b
PL_2 35%	5.53±0.01	23.91±0.45a	18.38±0.45a	332.48±8.36a	2.61±0.03a
PL_3 40%	5.54±0.01	24.79±0.61a	19.25±0.61a	347.26±11.01a	2.67±0.04a
Stocking Densitiy/m^3 (SR)					
SD_1 10/m^3	5.56±0.01	24.61±0.76a	19.07±0.76a	344.51±14.00a	2.65±0.06a
SD_2 15/m^3	5.53±0.01	23.03±0.71ab	17.47±0.71ab	314.38±13.10ab	2.53±0.06ab
SD_3 20/m^3	5.54±0.01	21.62±0.58b	16.08±0.58b	290.53±10.65b	2.42±0.05b
Interaction between Y*T					
PL_1* SD_1	5.54±0.01	21.73±0.39d	16.18±0.40d	291.84±7.63d	2.43±0.03d
PL_1* SD_2	5.57±0.01	20.45±0.42e	14.87±0.42e	266.77±7.79e	2.32±0.04e
PL_1* SD_3	5.55±0.02	19.47±0.35e	13.91±0.33e	250.42±5.36e	2.23±0.03e
PL_2* SD_1	5.52±0.02	25.49±0.31ab	19.97±0.33ab	361.87±6.98ab	2.73±0.03ab
PL_2* SD_2	5.54±0.04	23.49±0.44c	17.94±0.42c	323.53±6.70c	2.57±0.03c
PL_2* SD_3	5.52±0.01	22.76±0.46cd	17.23±0.46cd	312.05±8.10cd	2.53±0.04cd
PL_3* SD_1	5.54±0.01	26.61±0.47a	21.06±0.48a	379.83±9.19a	2.79±0.03a
PL_3* SD_2	5.55±0.04	25.14±0.21b	19.59±0.24b	352.83±6.28b	2.69±0.02b
PL_3* SD_3	5.53±0.02	22.64±0.47cd	17.10±0.46cd	309.12±7.69cd	2.51±0.33cd

±Mean values in each column followed by different superscript are significantly different ($p<0.05$)

protein quality, dietary level of energy, water quality, presence of natural food, and feeding and culture management (NRC, 1993). Also, for the protein levels, final body weight (FBW), body weight gain (WG), and weight gain % (RBWG) of *P. hypophthalmus* fry improved significantly ($P<0.05$) with increasing protein levels from 30 to 40% at the same stocking density level, and SGR linearly correlated with dietary protein level at each stocking density level ($p<0.05$). The optimal dietary protein for maximal growth of *P. hypophthalmus* was about 35 and 40 %, while the growth rate of *P. hypophthalmus* at 30% protein level was significantly different from 35 and 40 % protein levels, indicating that 30% dietary protein may meet the minimum protein requirement for *P. hypophthalmus*. On the other hands, as for the stocking density levels, fish growth decreased with increase in stocking density levels from 10 to 20 fish/ 150L at all the protein levels. So, the most growth was spotted at 10 stocking density compared to 15 and 20 fish/ 150L. Results suggest that *P. hypophthalmus* required high dietary levels of protein and low stocking density levels for fast growth.

Table 3: Feed utilization parameters by Pangasius catfish, *P. hypophthalmus* fingerlings fed experimental diets containing different protein and stocking density levels for 56 days.

Variable	FI	FCR	PER	APU	EU
Protein level, % (PL)					
PL_1 30%	27.51±0.37b	1.84±0.39a	1.68±0.19	27.04±1.28	20.27±0.39
PL_2 35%	32.12±0.55a	1.75±0.05ab	1.77±0.12	26.29±1.59	19.78±0.62
PL_3 40%	31.83±0.29a	1.66±0.05b	1.87±0.12	27.52±1.69	20.38±0.64
Stocking Densitiy/m^3 (SR)					
SD_1 10/m^3	30.47±0.88	1.61±0.04b	62.51±1.43a	2.19±0.05a	32.35±0.70a
SD_2 15/m^3	30.94±0.71	1.78±0.05a	56.37±1.67b	1.71±0.04b	25.91±0.56b
SD_3 20/m^3	30.04±0.92	1.87±0.02a	53.48±0.50b	1.43±0.01c	22.59±0.43c
Interaction between Y*T					
PL_1* SD_1	27.63±0.43b	1.71±0.06bc	2.05±0.08b	31.93±1.21a	20.97±0.80ab
PL_1* SD_2	28.42±0.54b	1.91±0.04a	1.58±0.02de	25.09±0.37cd	19.23±0.59bc
PL_1* SD_3	26.47±0.49b	1.90±0.01a	1.42±0.01f	24.09±0.24cde	20.62±0.18ab
PL_2* SD_1	31.47±1.71a	1.57±0.06cd	2.22±0.08a	32.03±1.78a	21.35±1.25ab
PL_2* SD_2	32.82±0.41a	1.83±0.06ab	1.66±0.05d	24.69±0.79c	18.98±0.73bc
PL_2* SD_3	32.06±0.36a	1.86±0.04a	1.43±0.03ef	22.14±0.64de	19.01±0.81bc
PL_3* SD_1	32.33±0.26a	1.53±0.03d	2.28±0.03a	33.08±0.95a	21.82±0.83a
PL_3* SD_2	31.59±0.75a	1.61±0.05cd	1.87±0.05c	27.93±0.05b	21.30±0.26ab

±Mean values in each column followed by different superscript are significantly different ($p<0.05$)

The present study demonstrates the existence of interactions between dietary protein and stocking density level on the growth of *P. hypophthalmus* fingerlings. Data indicated that the highest growth performance and nutrient utilization were attained with fish fed the 40% CP with 10 stocking density level, which was similar to and not significantly different from that recorded for 40% protein with stocking density level and 35% protein with 10 stocking density level ($P < 0.05$). The 35% protein with 10 stocking density level could therefore be deemed suitable for optimal growth of *P. hypophthalmus* fingerlings. Indicated that, the dietary protein levels can significantly affect the growth of *P. hypophthalmus* which is increased by any increase in dietary protein levels. (Liu *et al.,* 2011) found that, the dietary protein levels can significantly affect growth performance and SGR of *P. hypophthalmus*. The specific growth rate increased with the increase in either dietary protein level, suggesting *P. hypophthalmus* required high dietary levels of protein for fast growth. Similarly, Phumee et al. (2009) found that, the dietary levels of 400/120 g kg-1 protein/lipid were optimum for P. hypophthalmus. Also, Liu et al. (2011) found that, the highest SGR was observed of fish fed 453/86 g kg-1 protein/ lipid. Abd El-Naby, (2019) report that, the growth performance of *P. hypophthalmus* were significantly affected by dietary protein levels (P <

0.05). but with increase of stocking density, we showed decrease in the growth rate and that body weight and growth rate of fish were depressed when the fish were stocked at higher rates and the growth depression may be attributed to crowding, social interaction, and aggression. These results are in agreement with Ammar *et al.*, (2020) and Yakubu *et al*. (2017) reported that, the increasing of stocking density is an inhibitory factor for fish growth. Also, results of Abdel-Hakim *et al.* (2001) revealed that, the increasing stocking density for tilapia from 50 to 100 and 150 fish/m3 of tank water decreased significantly final body weight and length of fish.

Malik and Naeem (2020) demonstrated that, considerably significant growth results at investigational fish feed with feed 30% crude protein followed by feed with 25% crude protein whereas lowest was documented in fish fed with feed 20% crude protein. Suharmili *et al*. (2015) reported that the ideal diet protein requirement for lemon fin barb was 30% that relates to recent findings. The protein prerequisite for *P. hypophthalmus* growth is around 32.5% Hung *et al*. (2002) and 19-30% Hung *et al*. (2007).

Feed utilization parameters monitored (FI, FCR, PER, APU, and EU) of *P. hypophthalmus* fry after 56 days are presented in table 2. Generally, feed utilization was significantly affected ($p<0.05$) by protein levels and stocking densities and followed a trend similar to that observed for growth performance. Feed intake of fish fed at the diets at the same stocking density level increased with the increasing in protein levels from 30 to 40 %. Fish fed on diets with the same protein level, feed intake not significantly differed with increase in stocking density level from 10 to 20 fish/ 150 L. On the other hand, FCR was significantly ($p<0.05$) affected and generally tended to decrease by the increasing in dietary protein levels and stocking densities. Fish fed diet 40/10 protein/ stocking density and 35/10 protein/ stocking density diets had the highest and similar FCR values, closely followed by those fed 40/15 protein/ stocking density. These results are similar to that obtained by Kim and Lee (2005) who found that daily FI of bagrid catfish, *Pseudobagrus fulvidraco*, decreased with increasing dietary protein levels at 10 and. Abd El-Naby (2019) showed that Feed utilization by *P. hypophthalmus* was significantly affected ($p<0.05$) by protein levels.

Protein efficiency ratio (PER), apparent protein utilization (APU), and energy utilization (EU) not significantly affected ($p>0.05$) by the increase in dietary protein levels from 30 to 40%. In contrast, the increase in stocking density levels from 10 to 20 fish/ 150L across all protein levels resulted decreased of PER, APU, and EU. There were no significant ($P>0.05$) difference among the PER, APU, and EU of fish fed the 35/10% protein/ stocking density levels and those fed 40/10% protein/ stocking density levels, even though PER, APU, and EU of the 35/10% protein/ lipid diet were significantly (P<0.05) higher. These results are in agreement with Ahmad (2008) who indicated that the improvement in feed efficiency and protein utilization for African catfish fed diets containing 35% CP with 9% lipid related to the protein-sparing effect of lipid. The data of the present study approved that the interaction between protein and lipids had significant effects (P<0.05) on the feed utilization parameters. These results are similar to those obtained by Lee *et al.* (2002), Pei *et al.* (2004), Hung *et al.* (2004), Phumee *et al.* (2009), Azab *et al.*, (2018), and Abd El-Naby (2019).

According to De Silva and Phuong (2011), the FCR of commercial feeds ranges between 1.8 to 2.2, which is more than recent findings. According to Hillestad (2000) a low FCR acts as an indicator of improved consumption of feed. Kpogue *et al*, (2013) reported the best production and survival rate on increasing protein ratios (same as an above study) on 30%CP. The average survival rate in the recent studies varied from 85-98% which lies close to the findings of Abdel-Zaher. *et al*. (2009). According to Anguas-Vélez *et al*. (2000) that protein consumption is relatively insignificant and independent of the dietary protein level. As weight gain by fish is connected to protein deposition (Ishtiaq and Naeem 2019). This justifies the present results, as PER is low with increasing protein levels. Similarly, Sayeed and Hossain (2008) working on *P. hypophthalmus* used commercial feed (29% CP) according to Kader *et al.* (2003) reports that growth increase through a gradual increase in crude protein in diet which lies close to recent work (30%CP).

The result of carcass proximate analysis of the whole body for *P. hypophthalmus* was fed diets containing various dietary protein levels to stocking densities levels ratios were shown in Table 4. From this result, the moisture and body protein content were positively affected by dietary protein levels, body lipid and ash did not show any effect due to increasing dietary protein intake. No significant changes (P > 0.05) in protein and lipid contents were observed because of the variation in stocking density levels, so protein and stocking densities levels not significantly affected body protein and lipid contents (P< 0.05). Ash tended to increased significantly with any increase of stocking density levels at the same protein level (P < 0.05), but moisture significantly decreased with the increase of stocking density levels at all protein levels. The highest protein content was observed with fish fed the 40/20 protein/ stocking density levels. The interaction between dietary protein and stocking density levels had significant difference on body protein, lipid and ash content (P > 0.05). These results may be due to dietary protein uptake and protein deposition, which positively correlated with dietary protein levels. Similar relationships effects of increased dietary protein on elevating the body protein and reducing body lipid contents were observed in other fish species (Ahmad, 2008; Ali and Jauncey, 2005; Kim and Lee, 2005 and Abd El-Naby (2019).

Table 4: Whole body composition (% dry matter basis) of Pangasius catfish, *P. hypophthalmus* fingerlings fed experimental diets containing different protein and stocking density levels for 56 days

Variable	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)
Protein level, % (PL)				
PL_1 30%	75.07±0.17c	57.49±0.25b	15.91±0.19	17.65±0.24
PL_2 35%	76.41±0.18b	57.84±0.25b	15.68±0.25	18.24±0.16
PL_3 40%	77.41±0.20a	59.97±0.23a	15.81±0.23	18.10±0.23
Stocking Densitiy/m^3 (SR)				
SD_1 10/m^3	76.50±0.33a	57.82±0.39	16.26±0.15	21.38±0.50b
SD_2 15/m^3	76.32±0.29b	58.43±0.47	16.01±0.11	19.83±0.4a
SD_3 20/m^3	76.07±0.49b	59.05±0.39	15.13±0.19	19.22±0.45a
Interaction between Y*T				
PL_1* SD_1	75.47±0.03d	57.08±0.24e	16.28±0.36a	17.04±0.35b
PL_1* SD_2	75.28±0.11de	57.17±0.26e	15.93±0.27a	17.60±0.12ab
PL_1* SD_3	74.46±0.22e	58.21±0.45d	15.53±0.33b	18.32±0.34a
PL_2* SD_1	76.67±0.34bc	57.08±0.14e	16.18±0.31a	17.97±0.22ab
PL_2* SD_2	76.53±0.08bc	58.01±0.45de	16.03±0.12a	18.43±0.43a
PL_2* SD_3	76.05±0.39cd	58.45±0.19cd	14.84±0.34b	18.33±0.12a
PL_3* SD_1	77.35±0.53ab	59.31±0.35bc	16.32±0.19a	18.24±0.50a
PL_3* SD_2	77.16±0.32ab	60.11±0.34ab	16.06±0.24a	18.03±0.42ab
PL_3* SD_3	77.72±0.20a	60.48±0.19a	15.03±0.27b	18.02±0.45ab

±Mean values in each column followed by different superscript are significantly different ($p<0.05$)

Conclusion

Our results revealed that, the growth performance, feed utilization and body contents of Pangasius catfish; *P. hypophthalmus* are dependent on dietary protein levels. Based on results obtained in this study, the increase of dietary protein level with low stocking density levels seemed to have more beneficial effects on the performance and feed utilization. Therefore, the diet containing 35% protein with 10 stocking density levels suggested being suitable for the optimum growth and effective protein utilization of Pangasius catfish fingerlings.

Compliance with ethical standards

Conflict of interest: The author declares that they have no conflict of interest.

Ethical approval: All applicable international, national, and/or institutional guidelines for the care and use of fish were followed by the author

References

Abbass, F. E. (2007). Effect of dietary oil sources and levels on growth, feed utilization and whole-body chemical composition of common carp, *Cyprinus carpio* L. fingerlings. Journal of Fisheries and Aquatic Sciences 2(2):140–148.

Abd El- Naby, (2019). Growth response of Pangasius catfish (*Pangasius hypophthalmus*) fry to practical diets with varying dietary lipid and protein levels. Journal of the Arabian aquaculture society, 14: 1-13.

Abdel-Hakim, N.F; Hilali,I.A.; Khalil, M.H. and Al-Azab, A.A. (2001). Effect of stocking density and feeding rate on performance of Nile tilapia (*Oreochromis niloticus*) reared in Tanks. Egyptian J. Nutrition and Feeds. (Special Issue: 705-717.

Abdel-Zaher A, Mostafa Z M, Ahmad M H, Mousallamy A, Samir A, (2009). Effect of using dried Fenugreek seeds as natural feed additives on growth performance, feed utilization, whole-body composition and entropathogenic Aeromonas hydrophila-challinge of monsex Nile tilapia *O. niloticus* (L) fingerlings, Aust. J. Basic appl. Sci, 3, 2009, 234-1245.

Adewolu, M.A. & Benfey, T.J. (2009). Growth, nutrient utilization and body composition of juvenile bagrid catfish, *Chrysichthys nigrodigitatus* (Actinopterygii: Siluriformes: Claroteidae), fed different dietary crude protein levels. Acta Ichthyol. Pisc., 39: 95–101.

Ahmad, A.H. (2008). Response of African Catfish, *Clarias gariepinus*, to Different Dietary Protein and Lipid Levels in Practical Diets. Journal of the World Aquaculture Society, 39 (4): 541-548.

Ahmed, G.U., Hossain, M.M. & Hossain, M.S. (2009). Histopathology of Disease of an air Breathing Teleost Anabas testudineus (Bloch) from Freshwater Fisheries of Bangladesh, Int. J. Sustain. Agril. Tech., (5) 4: 75-81.

Akter, M.N., Ahmed, G.U. & Hossain, M.S. (2009). Seasonal Variation of Gill Pathology of a Climbing Perch In Lake Fisheries of Bangladesh, Int. J. Anim. Fish. Sci., 2 (3): 208-213.

Ali, M.Z. & Jauncey, K. (2005). Approaches to optimizing dietary protein to energy ratio for African catfish *Clarias gariepinus* (Burchell, 1822). Aquaculture Nutrition, 11: 95–101.

Ammar, A.A.; Khattaby, A.A. & Ahmed, K. M. (2020). Effect of initial weights and stocking densities on growth parameters and culture economics of Nile tilapia fish raised in earthen ponds, Egy.J.Aquac., 10(4):57-70.

Anguas-Vélez B H, Civera-Cerecedo R, Cadena-Roa M, Guillaume J, MartinezDiaz S F, (2000). Studies on the Nutrition of Spotted Sand Bass

Paralabrax maculatofasciatus: Effect of the Dietary Protein Level on Growth and Protein utilization in Juveniles Fed Semi purified Diets, J. of World Aqua Soci, 31, 2000, 580-591.

AOAC, (1990). Association of official analytical chemists. The Official Methods of Analyses Association of Official Analytical Chemists International.5th edition, Arlington, VA, USA.

Azab, A.M., Khalaf-Allah, H.M.M., Khattaby, A.A., Sadek, A.S.M. and Abdel-Ghany, M.O.M. (2018). Effect of stocking density and feeding rate on growth performance and total production of Nile tilapia, *Oreochromis niloticus* reared in earthen ponds. Egyptain journal for aquaculture, 8(3): 33-54.

Chattopadhyay, N.R., Mazumder, B. and Mazumdar, B. (2002). Induced spawning of *Pangasius sutchi* with pituitary extract. Aquaculture Asia, 7, 43-44.

Cho, C.Y. & Bureau, D.P. (2001). A review of diet formulation strategies and feeding systems to reduce excretory and feed wastes in aquaculture. Aquaculture Research, 32: 349-360.

Datta, S.N., Dhawan, A., Kumar, S., Parida P.and Kaur, K. (2014). Comparative economic analysis of pond aquaculture with and without cage. Eco. Env. Cons., (Supplement) 20: 297-301.

De Silva S S, Phuong N T, (2011). Striped catfish farming in the Mekong Delta, Vietnam: a tumultuous path to a global success, Rev Aquac, 3, 2011, 45–73.

Delgado, C.L., Wada, N., Rosegrant, M.W., Meijer, S. and Ahmed, M. (2003). Fish to 2020: Supply and demand in changing global markets. International Food Policy Research Institute (IFPRI), Washington and World Fish Center, Penang, Malaysia.

FAO (Food and Agriculture Organization). 2012. Pangasius market reports of FAO Globefish. Available at http://www.globefish.org/pangadec2012.html (accessed 15 June 2015).

Goering, H.K. & Van Soest, P.G. (1970). Forage fiber analysis (apparatus, reagent, procedures, and some applications). Washington, DC: U.S. Dept. of Agriculture.

Halwart, M., Soto, D. and Arthur, J.R. (2007). Cage aquaculture – Regional reviews and global overview. FAO Fisheries Technical Paper. No. 498. FAO, Rome, pp. 241.

Hillestad M, (2000). High-energy diets for Atlantic salmon: effect on growth, feed utilization, product quality and recipient loading. In: Reservoir and culture based fisheries: biology and management. Proc. of an International

Workshop held in Bangkok, Thailand from 15-18 February, 2000, 2001, 8lpp.

Hung L T, Liem P T, Tu H T, Mariojouls C, (2002). Comparing growth and protein requirements for fingerlings of three catfish of the Mekong River (*Pangasius bocourti, Pangagasius hypothalmus* and *Pangasius conchophilus*), J. of Aqua in the Tropics, 17(4), 2002, 325–335.

Hung L T, Truc L T T, Huy H P V, (2007). Case study on the use of farm-made feeds and commercially formulated pellets for pangasiid catfish culture in the Mekong Delta, Viet Nam: Study and analysis of feeds and fertilizers for sustainable aquaculture development. Food and Agriculture Organization of United Nation—FAO, Fisheries Technical, 497, 2007, 363-377.

Hung, L.T., Suhenda, N., Slembrouck, J., Lazard, J. & Moreau, Y. (2004). Comparison of dietary protein and energy utilization in three Asian catfishes (*Pangasius bocourti*, *P. hypophthalmus* and *P. djambal*). Aquaculture Nutrition, 10: 317-326.

Hung, L.T., Tuan, N.A. and Lazard, J. (2001). Effects of frequency and time of feeding on growth and feed utilization in two Asian cat fishes, Pangasius bocourti (Sauvage, 1880) and *Pangasius hypophthalmus* (Sauvage,1878). J. Aquacult. Trop.,16: 171-184.

Ishtiaq A, Naeem M, (2019). Effect of different dietary protein levels on growth performance of Catla catla (Hamilton) reared under polyculture system. Sarhad J. of Agri, 35(3), 2019, 976-984.

Jobling, M. (1994). Fish bioenergetics. Chapmen and Hall, London: 309pp.

Kader M A, Hossain M A, Hossain M D A, (2003). Comparative study on the effect of commercial fish feeds on the growth of Thai pangas, *Pangasius hypophthalmus*, Bangla. Fish. Res, 7(1), 2003, 53-58.

Karl, H., I. Lehmann, H. Rehbein, and R. Schubring. 2010. Composition and quality attributes of conventionally and organically farmed Pangasius fillets (*Pangasius hypophthalmus*) on the German market. Int. J. Food Sci. Technol. 45:56–66.

Kim, L.O. & Lee, S.M. (2005). Effects of the dietary protein and lipid levels on growth and body composition of Bagrid catfish (*Pseudobagrus fulvidraco*). Aquaculture, 243, 323-329.

Kpogue D N S, Ayanou G A, Toko I I, Mensah G A, Fiogbe E D, (2013). Influence of dietary protein levels on growth, feed utilization and carcass composition of snakehead, Parachanna obscura (Günther, 1861) fingerlings, Afri J. of Zool, Vol.1(4), 2013, 025-030.

Lee, S.M., Jeon, I.G. & Lee, J.Y. (2002). Effects of digestible protein and lipid levels in practical diets on growth, protein utilization and body composition of juvenile rock fish (*Sebastes schlegeli*). Aquaculture, 211: 227–239.

Lim, P.K., Boey, P.L. & Ng, W.K. (2001). Dietary palm oil level affects growth performance, protein retention and tissue vitamin E concentration of African catfish, *Clarias gariepinus*. Aquaculture, 202:101–112.

Ling, S., Hashim, R., Kolkovski, S. & Chong, A.S.C. (2006). Effects of varying dietary lipid and protein levels on growth and reproductive performance of female Swordtail (*Xiphorus helleri*, Poeciliidae). Aquaculture Research, 37: 1267–1275.

Liu, X.Y., Wang, Y. &JI, W.X. (2011). Growth, feed utilization and body composition of Asian catfish (*Pangasius hypophtthalmus*) fed at different dietary protein and lipid levels. Aquaculture Nutrition, 17: 578-584.

Lovell, T. (1989). Nutrition and feeding of fish. An AVI Book. Van Nostrand Reinhold, New York, New York, USA.

Malik, T. and Naeem, M. (2020). Effect of Dietary Protein Levels on Growth and Morphometrics of Striped Catfish *Pangasianodon Hypophthalmus* (Sauvage, 1878) From Pakistan. International journalof biology, pharmacy and applied science. 9(11): 3075-3087.

Miller, C.L., Davis, D.A. & Phelps, R.P. (2005). The effects of dietary protein and lipid on growth and body composition of juvenile and sub-adult red snapper, *Lutjanus campechanus* (Poey, 1860). Aquac, Res., 36: 52–60.

NRC (1993). Nutrient Requirements of Fish. National Academy press, Washington, D.C., USA.

Pei, Z., Xie, S., Lei, W.; Zhu, X. & Yang. Y. (2004). Comparative study on the effect of dietary lipid level on growth and feed utilization for gibel carp (*Carassius auratus gibelio*) and Chinese longsnout catfish (*Leiocassis longirostris Gu ¨nther*). Aquaculture Nutrition, 10:209–216.

Phan, L. T., T. M. Bui, T. T. T. Nguyen, G. J. Gooley, B. A. Ingram, H. V. Nguyen, et al. 2009. Current status of farming practices of striped catfish, *Pangasianodon hypophthalmus* in the Mekong Delta. Vietnam. Aquacult. 296:227–236.

Phumee, P., Hashim, R., Aliyu-Paiko, M. & Shu-Chien, A.C. (2009). Effects of dietary protein and lipid content on growth performance and biological indices of iridescent shark (*Pangasius hypophthalmus*, Sauvage 1878) fry. Aquaculture Research, 40: 456–463

Salhi, M., Bessonart, M., Chediak, G., Bellagamba, M. & Carnevia, D. (2004). Growth, feed utilization and body composition of black catfish, *Rhamdia quelen* fry fed diets containing different protein and energy levels. Aquaculture, 231: 435–444.

Sayeed M A B, Hossain S, (2008). Growth performance of thai pangus (*pangasius hypophthalmus*) in polyculture system using different supplementary feeds, Univ. j. zool. Rajshahi Univ, Vol. 27, 2008, 59-62.

Shearer, K.D. (2000). Experimental design, statistical analysis and modelling of dietary nutrient requirement studies for fish: a critical review. Aquaculture nutrition, 6(2): 91-102.

Smith, R.R. (1980). Nutritional bioenergetics. In: Fish Feed Technology. FAO/UNDP, Aquaculture Development and Coordination Programme, DCP/REP/80/l1, Rome, pp. 21–27.

Snedecor, G.W. and Cochran, W.G. (1981). Statistical Methods-Iowa state Univ., Ames, J.O., USA. 341 pp.

Suharmili R, Kamarudin M S, Saad C R, Ina-Salwany M Y, Ramezani-Fard E, Mahmud M H, (2015). Effects of varying dietary protein level on the growth, feed efficiency and body composition of lemon fin barb hybrid fingerlings. Iran, J. Fish. Sci, 14(2), 2015, 425-435.

Uddin, M.A. (2002). Effect of addition of small fish on the pond ecology and the production in poly culture”, MS Thesis. Department of Fisheries Management, BAU, Mymensingh, 81Pp.

Yakubu, A.F., A. Obi, V.A. Okonji, O.O. Ajiboye, T.E. Adams, E.D. Olaji and N.A. Nwogu, 2012. Growth performance of Nile tilapia (Oreochromis niloticus) as affected by stocking density and feed types in water flow through system. World Journal of Fish and Marine Sciences, 4(3): 320-324.

Yi, Y. and Lin, C.K. (2001). Effects of biomass of caged Nile tilapia (*Oreochromis niloticus*) and aeration on Nile tilapia (Oreochromis niloticus) and aeration on pond system. Aquaculture., 195, 253-267.

تأثير مستويات مختلفة من البروتين مع كثافات تسكين مختلفة على أداء النمو وكفاءة التحويل الغذائى لزريعة أسماك البانجاسيوس

عبدالرحمن أحمد خطابى

قسم بحوث إنتاج الأسماك ونظم الإستزراع السمكى، المعمل المركزى لبحوث الثروة السمكية،
مركز البحوث الزراعية، مصر

الملخص العربى

أجريت تجربة تغذية مدتها 56 يومًا للتحقق من البروتين الغذائي الأمثل وكثافة التخزين التي يمكن أن تعطي أداء نمو مثالي لسمك البنجاسيوس. تم استخدام 27 حوض (150 لتر / حوض) في هذه الدراسة. تم توزيع الأسماك إلى 9 معاملات. (ثلاث مكررات / لكل معاملة). تمت تركيب ثلاثة علائق تجريبية من ثلاثة مستويات بروتين مختلفة (30 ، 35 و 40٪) وثلاثة مستويات تكثيف مختلفة (10 ، 15 ، 20 سمكة / 150 لتر). تم تغذية إصبعيات البنجاسيوس (5.5 جم) بأحد العلائق المختبرة حتى الشبع الظاهر مرتين يوميًا في الساعة 09:00 والساعة 14:00. يمكن اعتبار النظام الغذائي الذي يحتوي على 10/35 بروتين / كثافة تخزين مناسبة للنمو الأمثل للأسماك وبقائها على قيد الحياة. كما سجلت نفس المعاملة اعلى معدل للاستخدام الامثل للعلائق. بالنسبة للتركيب الكيماوى لجسم السمكة لم تسجل أي فروق معنوية في محتويات الدهن والرماد في العلف الذي يتغذى بالجسم المحتوي على مستويات مختلفة من البروتين وكثافة التخزين. في حين تأثر محتوى الرطوبة وبروتين الجسم بشكل إيجابي بمستويات البروتين الغذائي. تشير النتائج إلى أن نظام تغذية الأسماك المحتوي على 35٪ بروتين بكثافة تخزين 10 سمكة / 150 لتر مناسب للنمو الأمثل لإصبعيات بنجاسيوس. *P. hypophthalmus*.