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**EFFECT OF DIETARY PROTEIN LEVELS ON GROWTH AND MORPHOMETRICS
OF STRIPED CATFISH *PANGASIANODON HYPOPHTHALMUS* (SAUVAGE, 1878)
FROM PAKISTAN**

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ABSTRACT

In recent study a 90 days feeding trial was conducted to evaluate the effect of dietary protein ratios on growth and morphometry in *Pangasianodon hypophthalmus*. Three commercially available diets with crude protein ratios 20% (T1), 25% (T2) and 30% (T3), by Supreme Aqua Feeds, were fed to *P. hypophthalmus* fry by initial weight and length 0.30g and 2.90cm respectively. Average final weight (26.84g), average final length (14.51cm), survival (98%) and Ccondition factor (0.88) were high for 30% CP (crude protein) Diet. FCR (feed conversion ratio) improved with increase in dietary protein moving from T1 to T3. Various morphometric parameters i.e. total length (TL), fork length (FL) standard length (SL), head length (HL), body depth (BD), body girth (BG), dorsal fin base (DFB), dorsal fin length (DFL), 2nddorsal fin base (2ndDFB), 2nddorsal fin length (2ndDFL), pelvic fin length (PvFL), pectoral fin length (PtFL), anal fin length (AFL), anal fin base(AFB), caudal fin length(CFL), head width (HW), eye diameter (ED), Inter-orbital distance (Int.OD), pre-orbital length (POL) of *P. hypophthalmus* were studied to know their correlation to size (TL). The favorable growth environment supported the survival of fish. However all diets improved the growth of fish, the 30% CP which resulted in best growth performance was probably adequate to meet the dietary protein needs of *P. hypophthalmus* fry in recent study.

Keywords: *Pangasianodon hypophthalmus*, crude protein ratios, commercial feed, growth performance, morphometrics

INTRODUCTION

Pangasianodon hypophthalmus is a benthopelagic omnivorous species that lives at a pH of 6.5 - 7.5 and a temperature range of 22 - 26°C [1]. Fish is one of the best source of cheap meat and protein necessity to half of the world's population that influences the ability of farmed fish to show their genetic prospective for reproduction and growth [2]. Currently, maximum farms use commercially produced feed [3] and the use of consumed protein in fish feed enhances the growth presentation [4]. Protein in fish farming is the chief costly component of artificial feed, it makes sense to only include that much, which is essential for usual preservation mandate and growth, extra protein is waste both biologically and economically [5] thus, cost-effective and well-adjusted diet had to be utilized for improving the fish production [6] and growth of fish [7]. The growth rate and feed conversion ratio (FCR) had an obvious impact by volume and value of diet fed by fish [6]. To identify and classify fishes, taxonomists and ichthyologists use various morphometric characteristics, including body length, head length, depth and fin lengths, standard and fork length of the fish [8]. It offers fundamental information, being useful to compare between-region comparisons

growth, to estimate the length of an individual fish of known weight or vice versa [9], to evaluate the isometric and allometric growth pattern in fish [10]. Several factors, like age, food availability and its source, physiochemical parameters of water for fish growth and sexual maturity of fish, may influence on K-value [11]. Furthermore, it can also be used in assessing the well-being of fish [12]. Hence, the purpose of recent study was to evaluate the impact of commercial protein diet of three levels (20%, 25% and 30% crude protein) at *P. hypophthalmus* on account of growth and morphometrics.

MATERIALS AND METHODS**Experimental site**

The feeding trial was demonstrated at the Fish Farm Facility Tawakkal Nagar, Muzaffar Garh in

Cemented ponds (indoor) for 90 days. The fish selected for experiment was *Pangasianodon hypophthalmus* fry. The average initial wet body weight and the average initial body length were measured at the time of stocking. The area for each cemented nursery pond was 2.48m².

Experimental design

Three treatments were designed on the grounds of three percentages of

commercially available protein diet by Supreme Aqua Feeds. As T1=20%, T2=25% and T3=30% crude protein diet. The ponds were washed with an antiseptic, then each treatment was stocked with 100 fish fry (50 each replicate). The water quality was monitored and changed periodically to avoid turbidity, aerators were used to keep oxygen supply constant. The daily feed ratio was 5% of body biomass.

Determination of Growth profile

At the end of feeding trial all fish were harvested and brought to the fisheries lab at Institute of Pure and Applied Biology (Zoology Division) Bahauddin Zakariya University, Multan. The final weight and length and various growth parameters were measured for observing growth efficiency of *P. hypophthalmus* raised at commercial protein diet.

Determination of Morphometrics

In recent study 60 randomly selected fish specimens were used, 20 from each treatment. Morphometry was demonstrated at completion of growth experiment. At arrival in the laboratory, the fish were weighted (g) on an electric digital balance and length measurements (cm) were taken. The morphometric parameters FL, SL, HL, BD, BG, DFB, DFL, 2ndDFB, 2ndDFL, PvFL, PtFL, AFL, AFB, CFL, HW, ED, Int.OD,

and POL of *P. hypophthalmus* were measured.

Data analysis

Using descriptive statistics growth data was expressed as Mean values. Whereas, correlation of morphometric parameters towards body size (TL) was calculated by linear regression, the data was transformed into logarithm by using MS-Excel 2016. This logarithm transformed data was then used for further analysis of total length relationships by; $[\text{Log } Y = a + b \text{ Log } X]$. Where 'a' and 'b' are constants of the relationship, representing the intersect part of the "Y" axis and slope of the equation, respectively.

RESULTS

Growth performance of *P. hypophthalmus*

The Growth parameters of *Pangasianodon hypophthalmus* in various treatments i.e. T1 (20%), T2 (25%) and T3 (30%) are shown in **Table 1**. The commercial crude protein diet by Supreme Aqua Feeds significantly affected the experimental groups. There was no significant difference between initial weight and length of all treatments but final weight and length increases for all groups under concern. Whereas the significant difference was observed among the final weight and length of all treatments. The final length and weight i.e. 26.84g and 14.51cm were observed to be highest in T3. Body

weight (W) and Total length (TL) rises in order $T3 > T2 > T1$. The live weight gain i.e. 2600.32g was highest in T3 in contrast to T2 (2259.06g) and T1 (2048.3g). The condition factor was observed as T1 0.87, T2 0.83 and T3 0.88 however T3 was found significantly high. The values for FCR were identified as 1.29, 1.26 and 1.23 for T1, T2 and T3 respectively. However significantly lower value was observed in T3 as compare to T1 and T2. Highest production and the survival percentage was 11.650 gram/m²/90days and 98% for T3 (30% CP) respectively (**Table 1**).

External Morphometric Variants of *P.hypophthalmus*

The **Table 2** signifies the mean (\pm Standard Deviation) and range values for morphometric variants in three treatments of *Pangasianodon hypophthalmus*. The highest values for mean Body weight (wet) (WW) 26.84 \pm 2.38, Condition factor (K) 0.88 \pm 0.05, Total length (TL) 14.51 \pm 0.54, Fork length (FL) 13.08 \pm 0.81, Standard length (SL) 12.42 \pm 0.65, Body depth (BD) 4.54 \pm 0.25 and Body girth (BG) 9.09 \pm 0.50 were all observed in group fed at 30% CP diet (T3). Moreover, Dorsal fin length (DFL) 2.22 \pm 0.18, Pelvic fin

length (PvFL) 1.52 \pm 0.10, Anal fin length (AFL) 1.86 \pm 0.18, Anal fin base (AFB) 4.04 \pm 0.18 and Caudal fin length (CFL) 2.54 \pm 0.30 were also found to be highest in T3. In **Table 3** a highly significant and positive correlation was recorded for wet body-weight (w.W) and most of parameters towards TL. The regression analysis among log of various morphometric parameters of *P. hypophthalmus* toward log total length (cm) for three diet treatments is shown in **Table 4**. The Correlation coefficient values for all the three treatments ranged from 0.84 - 0.90 were highly significant ($P < 0.001$) between W and TL in log transformed data. The regression coefficient i.e. b value is ranged from 2.00 - 2.97 that is near to an ideal slope value ($b=3$). Therefore growth was seen to be isometric in T1 and negative allometry in T2 and T3. *P. hypophthalmus*. The log Condition factor specifies a significant relation (0.644) towards T3. Were as other morphometric parameters express highly significant relations towards body size (log TL), expressing good effect of feed at morphometry (**Table 4**).

Table 1: Growth demonstration of *Pangasianodon hypophthalmus* (Sauvage, 1878) reared 90 days at various protein ratios of commercial diet in cemented fish-ponds

| Parameters | T-1 20% CP | T-2 25% CP | T-3 30% CP |
|-------------------------------------|---------------|---------------|---------------|
| Rearing-period | 90(days) | 90(days) | 90(days) |
| No. of-Stock | 100 | 100 | 100 |
| FeedingRate/BodyWeight | 5% | 5% | 5% |
| Initial-Weight(g)(Average) | 0.30 | 0.30 | 0.30 |
| Final Weight(g)(Average) | 24.38 | 25.16 | 26.84 |
| Live weight gain (g) | 2048.3 | 2259.06 | 2600.32 |
| Average Initial length (cm) | 2.90 | 2.90 | 2.90 |
| Average Final length (cm) | 14.06 | 14.47 | 14.51 |
| Length gain (cm) | 11.16 | 11.57 | 11.61 |
| Daily Weight Gain (g) | 22.76 | 25.10 | 27.70 |
| Survival (%) | 85% | 91% | 98% |
| Average Initial-Condition- Factor | 1.46 | 1.46 | 1.46 |
| Average Final-Condition- Factor | 0.87 | 0.83 | 0.88 |
| FCR(FeedConversionRatio) | 1.29 | 1.26 | 1.23 |
| Protein efficiency ratio | 3.86 | 3.18 | 2.71 |
| Specific Growth rate | 2.230 | 2.129 | 2.169 |
| Production g/m ² /90days | 9.177 | 10.121 | 11.650 |

Table 2: Average-Values Analysis for External-Morphology of *P.hypophthalmus* (n=20)

| Body Measurements | T1(20%) | | T2(25%) | | T3(30%) | |
|---|-------------|-------------|-------------|-------------|-------------|-------------|
| | Average±S.D | Ranges | Average±S.D | Ranges | Average±S.D | Ranges |
| BodyWeight(Wet)(WW)g | 24.38±3.13 | 19.10-29.00 | 25.16±3.87 | 21.70-33.20 | 26.84±2.38 | 23.90-31.30 |
| Condition Factor(K) | 0.87±0.06 | 0.75-1.00 | 0.83±0.05 | 0.76-0.99 | 0.88±0.05 | 0.81-0.97 |
| Total length(TL)cm | 14.06±0.52 | 13.10-14.70 | 14.47±0.69 | 13.70-15.90 | 14.51±0.54 | 13.50-15.20 |
| Fork-Length(FL)cm | 12.56±0.53 | 11.60-13.20 | 12.52±0.28 | 12.20-13.10 | 13.08±0.81 | 11.50-14.00 |
| Standard Length(SL)cm | 11.90±0.38 | 11.20-12.40 | 11.72±0.27 | 11.40-12.20 | 12.42±0.65 | 11.00-13.30 |
| Head-Length(HL)cm | 2.74±0.12 | 2.60-2.90 | 2.92±0.23 | 2.50-3.20 | 2.66±0.26 | 2.10-2.90 |
| Body-Depth(BD)cm | 3.68±0.22 | 3.25-3.95 | 3.75±0.12 | 3.55-3.90 | 4.54±0.25 | 4.25-4.95 |
| Body-Girth(BG)cm | 7.36±0.44 | 6.50-7.90 | 7.50±0.24 | 7.10-7.80 | 9.09±0.50 | 8.50-9.90 |
| DorsalFinLength(DFL) cm | 2.20±0.17 | 1.90-2.40 | 2.12±0.18 | 1.80-2.30 | 2.22±0.18 | 1.90-2.40 |
| Dorsal-FinBase(DFB) cm | 0.98±0.13 | 0.80-1.10 | 0.90±0.07 | 0.80-1.00 | 0.94±0.08 | 0.90-1.10 |
| 2 nd DorsalFinLength (2 nd DFL)cm | 0.60 ±0.06 | 0.50-0.70 | 0.58±0.04 | 0.50-0.60 | 0.57±0.05 | 0.50-0.60 |
| 2 nd DorsalFinBase (2 nd DFB)cm | 0.23±0.05 | 0.20-0.30 | 0.28±0.04 | 0.20-0.30 | 0.28±0.04 | 0.20-0.30 |
| Pectoral-Fin Length (PtFL)cm | 1.88±0.10 | 1.70-2.00 | 1.94±0.11 | 1.80-2.10 | 1.92±0.21 | 1.50-2.20 |
| Pelvic-FinLength (PvFL)cm | 1.48±0.07 | 1.40-1.60 | 1.48±0.08 | 1.40-1.60 | 1.52±0.10 | 1.40-1.70 |
| AnalFinLength(AFL) cm | 1.70±0.14 | 1.60-1.90 | 1.50±0.13 | 1.30-1.70 | 1.86±0.18 | 1.50-2.10 |
| Anal-Fin Base (AFB) cm | 3.86±0.21 | 3.50-4.10 | 3.78±0.16 | 3.50-4.00 | 4.04±0.18 | 3.70-4.20 |
| Caudal-Fin Length (CFL)cm | 2.36±0.20 | 2.00-2.60 | 2.38±0.09 | 2.30-2.50 | 2.54±0.30 | 2.10-2.90 |
| Head-Width(HW)cm | 1.90±0.22 | 1.70-2.30 | 2.70±0.23 | 2.30-2.90 | 2.60±0.26 | 1.90-2.80 |
| EyeDiameter(ED)cm | 0.58±0.04 | 0.50-0.60 | 0.57±0.05 | 0.50-0.60 | 0.58±0.04 | 0.50-0.60 |
| InterOrbital Distance(Int.OD)cm | 3.07±0.05 | 3.00-3.10 | 3.54±0.08 | 3.40-3.60 | 3.08±0.04 | 3.00-3.10 |
| Pre-Orbital Length (POL)cm | 0.53±0.07 | 0.40-0.60 | 0.87±0.05 | 0.80-0.90 | 0.48±0.04 | 0.40-0.50 |

S.D=Standard Deviation

Table 3: Analysing Regression among different morphometric considerations of *Pangasianodon hypophthalmus* toward total length(cm) for T1=20%.(n=20)

| Equations. | Diet Variables. | [Relationship Parameters. | | a (CI.95%) | b (CI.95%) | r. | r. ² |
|---------------------------------|-----------------|---------------------------|--------|-------------------|-----------------|---------------------|-----------------|
| | | a | b | | | | |
| W= (a+b)TL | T1(20%) | -47.1873 | 5.09 | 69.366 - -25.009 | 3.514 - 6.667 | 0.848*** | 0.719 |
| | T2(25%) | -48.7850 | 5.11 | -65.741 - -31.829 | 3.941 - 6.283 | 0.908*** | 0.824 |
| | T3(30%) | -28.0857 | 3.79 | -44.298 - -11.873 | 2.669 - 4.903 | 0.859*** | 0.738 |
| K= (a +b)TL | T1(20%) | 0.9077 | -0.002 | 0.108 - 1.707 | -0.059 - 0.054 | 0.021 ns | 0.0004 |
| | T2(25%) | 0.9883 | -0.01 | 0.438 - 1.539 | -0.049 - 0.027 | 0.144 ns | 0.021 |
| | T3(30%) | 1.7760 | -0.06 | 1.253 - 2.299 | -0.098 - -0.026 | 0.648** | 0.420 |
| F.L= (a+ b)TL | T1(20%) | 2.3782 | 0.72 | -2.656 - 7.413 | 0.366 - 1.082 | 0.708*** | 0.501 |
| | T2(25%) | 7.6249 | 0.34 | 5.923 - 9.327 | 0.221 - 0.456 | 0.819*** | 0.670 |
| | T3(30%) | -0.0738 | 0.91 | -8.618 - 8.470 | 0.318 - 1.495 | 0.606** | 0.368 |
| SL= (a+ b)TL | T1(20%) | 2.9750 | 0.63 | 0.411 - 5.539 | 0.452 - 0.817 | 0.865*** | 0.748 |
| | T2(25%) | 6.7281 | 0.35 | 5.407 - 8.049 | 0.254 - 0.436 | 0.882*** | 0.778 |
| | T3(30%) | -2.9992 | 1.06 | -7.172 - 1.173 | 0.776 - 1.351 | 0.878*** | 0.770 |
| HL= (a+ b)TL | T1(20%) | 0.8013 | 0.14 | -0.458 - 2.060 | 0.048 - 0.227 | 0.606** | 0.367 |
| | T2(25%) | -0.4907 | 0.24 | -2.240 - 1.259 | 0.115 - 0.357 | 0.695*** | 0.483 |
| | T3(30%) | -3.2002 | 0.40 | -5.098 - -1.303 | 0.273 - 0.535 | 0.837*** | 0.701 |
| BD=(a+b)TL | T1(20%) | -1.0802 | 0.34 | -2.798 - 0.637 | 0.216 - 0.460 | 0.808*** | 0.653 |
| | T2(25%) | -0.3296 | 0.34 | -1.285 - 0.626 | 0.271 - 0.403 | 0.930*** | 0.865 |
| | T3(30%) | 2.0811 | 0.11 | 0.716 - 3.446 | 0.021 - 0.209 | 0.518* | 0.268 |
| BG=(a+ b)TL | T1(20%) | -2.1604 | 0.68 | -5.596 - 1.275 | 0.433 - 0.921 | 0.808*** | 0.653 |
| | T2(25%) | -0.6592 | 0.67 | -2.571 - 1.252 | 0.542 - 0.806 | 0.930*** | 0.865 |
| | T3(30%) | 4.1622 | 0.23 | 1.432 - 6.892 | 0.042 - 0.418 | 0.518* | 0.268 |
| DFL=(a+b)TL | T1(20%) | 0.4794 | 0.12 | -1.610 - 2.569 | -0.026 - 0.271 | 0.378 ns | 0.143 |
| | T2(25%) | -0.1452 | 0.16 | -1.645 - 1.354 | 0.053 - 0.260 | 0.599** | 0.359 |
| | T3(30%) | -1.9194 | 0.29 | -3.222 - -0.617 | 0.196 - 0.375 | 0.844*** | 0.713 |
| 2 nd DFL=(a+b)TL | T1(20%) | -0.4105 | 0.07 | -1.120 - 0.299 | 0.021 - 0.122 | 0.577** | 0.332 |
| | T2(25%) | 0.0708 | 0.03 | -0.320 - 0.461 | 0.008 - 0.062 | 0.539* | 0.290 |
| | T3(30%) | 0.5296 | 0.002 | -0.122 - 1.181 | -0.042 - 0.047 | 0.027 ^{ns} | 0.0007 |
| Pt.FL= (a+ b)TL | T1(20%) | -0.2280 | 0.15 | -0.995 - 0.539 | 0.095 - 0.204 | 0.806*** | 0.649 |
| | T2(25%) | 0.9913 | 0.07 | -0.051 - 2.034 | -0.006 - 0.138 | 0.411 ^{ns} | 0.169 |
| | T3(30%) | 0.1089 | 0.12 | -2.484 - 2.702 | -0.054 - 0.303 | 0.326 ^{ns} | 0.106 |
| PvFL = (a+ b)TL | T1(20%) | 0.6224 | 0.06 | -0.206 - 1.451 | 0.002 - 0.120 | 0.456* | 0.208 |
| | T2(25%) | 0.3577 | 0.08 | -0.248 - 0.964 | 0.035 - 0.119 | 0.675** | 0.455 |
| | T3(30%) | -0.0288 | 0.11 | -1.184 - 1.127 | 0.027 - 0.186 | 0.552* | 0.305 |
| CFL= (a+ b)TL | T1(20%) | 0.5961 | 0.13 | -1.839 - 3.031 | -0.048 - 0.298 | 0.337 ^{ns} | 0.114 |
| | T2(25%) | 0.9667 | 0.10 | 0.350 - 1.584 | 0.055 - 0.140 | 0.750*** | 0.563 |
| | T3(30%) | -3.6927 | 0.43 | -6.226 - -1.159 | 0.255 - 0.604 | 0.773*** | 0.598 |
| AFL= (a+ b)TL | T1(20%) | -0.4030 | 0.15 | -1.859 - 1.053 | 0.046 - 0.253 | 0.582** | 0.339 |
| | T2(25%) | 0.3706 | 0.08 | -0.816 - 1.557 | -0.004 - 0.160 | 0.427 ^{ns} | 0.182 |
| | T3(30%) | -0.6163 | 0.17 | -2.659 - 1.427 | 0.030 - 0.311 | 0.515* | 0.265 |
| HW = (a+ b)TL | T1(20%) | -2.8249 | 0.34 | -4.664 - -0.986 | 0.205 - 0.467 | 0.786*** | 0.618 |
| | T2(25%) | -0.5268 | 0.22 | -2.309 - 1.255 | 0.100 - 0.346 | 0.668** | 0.446 |
| | T3(30%) | 0.4164 | 0.15 | -2.911 - 3.743 | -0.079 - 0.379 | 0.309 ^{ns} | 0.095 |
| E.D= (a+ b)TL | T1(20%) | 0.3233 | 0.02 | -0.211 - 0.858 | -0.020 - 0.056 | 0.232 ns | 0.054 |
| | T2(25%) | 0.7981 | -0.02 | 0.301 - 1.296 | -0.050 - 0.018 | 0.226 ^{ns} | 0.051 |
| | T3(30%) | -0.2909 | 0.06 | -0.627 - 0.045 | 0.037 - 0.083 | 0.789*** | 0.623 |
| IntO.D=(a+b)TL | T1(20%) | 2.1250 | 0.07 | 1.705 - 2.545 | 0.037 - 0.097 | 0.744*** | 0.554 |
| | T2(25%) | 3.5277 | 0.001 | 2.679 - 4.376 | -0.058 - 0.059 | 0.004 ^{ns} | 1.8E-05 |
| | T3(30%) | 3.0485 | 0.002 | 2.502 - 3.595 | -0.035 - 0.040 | 0.029 ^{ns} | 0.001 |
| POL= (a+ b)TL | T1(20%) | 1.2624 | -0.05 | 0.275 - 2.249 | -0.123 - 0.018 | 0.347 ns | 0.121 |
| | T2(25%) | 0.6296 | 0.02 | 0.154 - 1.106 | -0.016 - 0.049 | 0.243 ^{ns} | 0.059 |
| | T3(30%) | -0.1611 | 0.04 | -0.662 - 0.340 | 0.009 - 0.078 | 0.533* | 0.284 |
| DFB = (a+ b)TL | T1(20%) | -0.9154 | 0.13 | -2.351 - 0.520 | 0.033 - 0.237 | 0.548* | 0.300 |
| | T2(25%) | -0.0351 | 0.06 | -0.583 - 0.513 | 0.026 - 0.102 | 0.644** | 0.414 |
| | T3(30%) | 0.3209 | 0.04 | -0.729 - 1.371 | -0.030 - 0.115 | 0.281 ^{ns} | 0.079 |
| 2 nd DFB = (a+ b)TL | T1(20%) | -0.4364 | 0.05 | -0.972 - 0.099 | 0.009 - 0.085 | 0.525* | 0.275 |
| | T2(25%) | -0.2292 | 0.03 | -0.620 - 0.161 | 0.008 - 0.062 | 0.539* | 0.290 |
| | T3(30%) | 0.4521 | -0.01 | -0.133 - 1.037 | -0.053 - 0.028 | 0.148 ^{ns} | 0.022 |
| AFB=(a+b)TL | T1(20%) | 4.1932 | -0.02 | 1.438 - 6.948 | -0.220 - 0.172 | 0.060 ns | 0.004 |
| | T2(25%) | 1.2863 | 0.17 | 0.183 - 2.389 | 0.096 - 0.248 | 0.746*** | 0.556 |
| | T3(30%) | 0.7190 | 0.229 | -0.950 - 2.388 | 0.114 - 0.344 | 0.702*** | 0.493 |

Table 4: Regression analysis among log of different morphometric parameters of *P. hypophthalmus* toward log total length(cm) at three diet treatments (n=20)

| Equations. | Diet Variables. | [Relationship Parameters. | | a (CI.95%) | b (CI.95%) | r. | r. ² |
|--|-----------------|---------------------------|-------|-----------------|-----------------|---------------------|-----------------|
| | | a | b | | | | |
| Log.W=(a+b)LogTL | T1(20%) | -2.0207 | 2.97 | -3.069 - -0.973 | 2.053 - 3.879 | 0.849*** | 0.721 |
| | T2(25%) | -1.8502 | 2.80 | -2.607 - -1.094 | 2.147 - 3.451 | 0.905*** | 0.819 |
| | T3(30%) | -0.8996 | 2.00 | -1.579 - -0.220 | 1.418 - 2.589 | 0.861*** | 0.742 |
| Log.K=(a +b)LogTL | T1(20%) | -0.0207 | -0.03 | -1.069 - 1.027 | -0.947 - 0.879 | 0.018 ^{ns} | 0.0003 |
| | T2(25%) | 0.1498 | -0.20 | -0.607 - 0.906 | -0.853 - 0.451 | 0.151 ^{ns} | 0.023 |
| | T3(30%) | 1.1004 | -1.00 | 0.421 - 1.780 | -1.582 - -0.411 | 0.644** | 0.415 |
| Log.F.L=(a + b)LogTL | T1(20%) | 0.1712 | 0.81 | -0.290 - 0.633 | 0.406 - 1.210 | 0.705*** | 0.497 |
| | T2(25%) | 0.6440 | 0.39 | 0.482 - 0.806 | 0.251 - 0.531 | 0.811*** | 0.658 |
| | T3(30%) | -0.0750 | 1.03 | -0.845 - 0.696 | 0.362 - 1.689 | 0.608** | 0.369 |
| Log.SL=(a + b)LogTL | T1(20%) | 0.2261 | 0.74 | -0.021 - 0.473 | 0.524 - 0.955 | 0.862*** | 0.743 |
| | T2(25%) | 0.5691 | 0.43 | 0.436 - 0.702 | 0.316 - 0.546 | 0.880*** | 0.775 |
| | T3(30%) | -0.3653 | 1.26 | -0.759 - 0.029 | 0.917 - 1.596 | 0.878*** | 0.771 |
| Log.HL=(a + b)LogTL | T1(20%) | -0.3617 | 0.70 | -0.888 - 0.164 | 0.237 - 1.154 | 0.601** | 0.361 |
| | T2(25%) | -0.8973 | 1.17 | -1.637 - -0.157 | 0.536 - 1.812 | 0.673** | 0.454 |
| | T3(30%) | -2.2465 | 2.30 | -3.107 - -1.386 | 1.558 - 3.040 | 0.838*** | 0.702 |
| Log.BD=(a+b)LogTL | T1(20%) | -0.9331 | 1.31 | -1.468 - -0.398 | 0.839 - 1.771 | 0.811*** | 0.658 |
| | T2(25%) | -0.5987 | 1.08 | -0.846 - -0.351 | 0.869 - 1.296 | 0.929*** | 0.863 |
| | T3(30%) | 0.0700 | 0.43 | -0.352 - 0.492 | 0.070 - 0.797 | 0.508* | 0.259 |
| Log.BG=(a + b)LogTL | T1(20%) | -0.6320 | 1.31 | -1.167 - -0.097 | 0.839 - 1.771 | 0.811*** | 0.658 |
| | T2(25%) | -0.2977 | 1.08 | -0.545 - -0.050 | 0.869 - 1.296 | 0.929*** | 0.863 |
| | T3(30%) | 0.3710 | 0.43 | -0.051 - 0.793 | 0.070 - 0.797 | 0.508* | 0.259 |
| Log.DFL=(a+b)LogTL | T1(20%) | -2.2923 | 1.99 | -3.980 - -0.605 | 0.516 - 3.457 | 0.556* | 0.309 |
| | T2(25%) | -0.9516 | 1.10 | -1.821 - -0.082 | 0.351 - 1.850 | 0.588** | 0.346 |
| | T3(30%) | -1.8544 | 1.89 | -2.550 - -1.158 | 1.295 - 2.493 | 0.843*** | 0.710 |
| Log.2 nd DFL=(a+b)LogTL | T1(20%) | -2.2113 | 1.73 | -3.548 - -0.875 | 0.567 - 2.896 | 0.593** | 0.351 |
| | T2(25%) | -1.3473 | 0.95 | -2.182 - -0.513 | 0.234 - 1.673 | 0.549* | 0.301 |
| | T3(30%) | -0.3003 | 0.04 | -1.668 - 1.068 | 1.134 - 1.222 | 0.018 ^{ns} | 0.0003 |
| Log.Pt.FL=(a + b)LogTL | T1(20%) | -1.0355 | 1.14 | -1.509 - -0.562 | 0.727 - 1.552 | 0.807*** | 0.652 |
| | T2(25%) | -0.2860 | 0.49 | -0.915 - 0.343 | -0.048 - 1.036 | 0.411 ^{ns} | 0.169 |
| | T3(30%) | -0.8164 | 0.94 | -2.486 - 0.854 | -0.494 - 2.382 | 0.309 ^{ns} | 0.096 |
| Log.PvFL = (a + b)LogTL | T1(20%) | -0.4913 | 0.58 | -1.122 - 0.139 | 0.027 - 1.125 | 0.461* | 0.213 |
| | T2(25%) | -0.7063 | 0.75 | -1.192 - -0.221 | 0.336 - 1.172 | 0.666** | 0.443 |
| | T3(30%) | -0.9202 | 0.95 | -1.791 - -0.049 | 0.197 - 1.697 | 0.530* | 0.281 |
| Log.CFL= (a + b)LogTL | T1(20%) | -0.4638 | 0.73 | -1.676 - 0.749 | -0.329 - 1.783 | 0.323 ^{ns} | 0.104 |
| | T2(25%) | -0.3171 | 0.60 | -0.623 - -0.011 | 0.334 - 0.862 | 0.746*** | 0.557 |
| | T3(30%) | -2.5352 | 2.53 | -3.673 - -1.397 | 1.550 - 3.509 | 0.788*** | 0.620 |
| Log.AFL= (a + b)LogTL | T1(20%) | -1.1411 | 1.19 | -2.090 - -0.192 | 0.367 - 2.021 | 0.582** | 0.338 |
| | T2(25%) | -0.7179 | 0.77 | -1.665 - 0.229 | -0.047 - 1.586 | 0.423 ^{ns} | 0.179 |
| | T3(30%) | -1.2707 | 1.32 | -2.631 - 0.090 | 0.15 - 2.496 | 0.488* | 0.239 |
| Log.HW = (a + b)LogTL | T1(20%) | -2.4876 | 2.41 | -3.543 - -1.432 | 1.488 - 3.328 | 0.792*** | 0.627 |
| | T2(25%) | -1.0403 | 1.27 | -1.842 - -0.238 | 0.576 - 1.959 | 0.672** | 0.452 |
| | T3(30%) | -0.5195 | 0.80 | -2.186 - 1.147 | -0.633 - 2.237 | 0.267 ^{ns} | 0.071 |
| Log-E.D= (a + b)LogTL | T1(20%) | -0.7758 | 0.47 | -1.879 - 0.328 | -0.493 - 1.430 | 0.235 ^{ns} | 0.055 |
| | T2(25%) | 0.2639 | -0.44 | -0.806 - 1.334 | -1.365 - 0.479 | 0.231 ^{ns} | 0.053 |
| | T3(30%) | -2.0865 | 1.59 | -2.778 - -1.395 | 0.997 - 2.187 | 0.798*** | 0.637 |
| Log.IntO.D=(a + b)LogTL | T1(20%) | 0.1343 | 0.31 | -0.021 - 0.290 | 0.172 - 0.443 | 0.747*** | 0.558 |
| | T2(25%) | 0.5453 | 0.003 | 0.260 - 0.831 | -0.244 - 0.249 | 0.005 ^{ns} | 2.73E-05 |
| | T3(30%) | 0.4772 | 0.01 | 0.271 - 0.683 | -0.168 - 0.187 | 0.027 ^{ns} | 0.001 |
| Log.P.OL= (a + b)LogTL | T1(20%) | 1.3368 | -1.41 | -0.911 - 3.585 | -3.372 - 0.546 | 0.336 ^{ns} | 0.113 |
| | T2(25%) | -0.4065 | 0.30 | -1.067 - 0.254 | -0.272 - 0.867 | 0.251 ^{ns} | 0.063 |
| | T3(30%) | -1.9592 | 1.41 | -3.246 - -0.672 | 0.299 - 2.515 | 0.532* | 0.283 |
| Log.DFB = (a + b)LogTL | T1(20%) | -2.2923 | 1.99 | -3.980 - -0.605 | 0.516 - 3.457 | 0.556* | 0.309 |
| | T2(25%) | -1.2337 | 1.02 | -1.978 - -0.489 | 0.379 - 1.663 | 0.619** | 0.383 |
| | T3(30%) | -0.7405 | 0.61 | -1.953 - 0.472 | -0.431 - 1.657 | 0.279 ^{ns} | 0.078 |
| Log.2 nd DFB = (a + b)LogTL | T1(20%) | -3.6941 | 2.66 | -6.162 - -1.227 | 0.506 - 4.805 | 0.522* | 0.272 |
| | T2(25%) | -3.0257 | 2.12 | -4.882 - -1.169 | 0.520 - 3.720 | 0.549* | 0.301 |
| | T3(30%) | 0.2884 | -0.74 | -2.441 - 3.018 | -3.087 - 1.614 | 0.153 ^{ns} | 0.024 |
| Log.AFB=(a+b)LogTL | T1(20%) | 0.7055 | -0.10 | -0.116 - 1.527 | -0.820 - 0.611 | 0.072 ^{ns} | 0.005 |
| | T2(25%) | -0.1967 | 0.67 | -0.547 - 0.154 | 0.365 - 0.969 | 0.738*** | 0.544 |
| | T3(30%) | -0.3669 | 0.84 | -0.853 - 0.120 | 0.419 - 1.257 | 0.704*** | 0.495 |

correlation coefficient (r), r²: coefficient of determination, intercept (a), regression coefficient (b), CI: confidence intervals, *** p < 0.001, ** p < 0.01, * p < 0.05

DISCUSSION

Growth Study

The growth study on striped catfish, reared in various crude protein ratios of commercial diets represents that parameters such as average weight gain, average length gain, FCR, live weight gain, daily weight gain condition factor and production; here current study demonstrates 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. [13] reported that ideal diet protein requirement for lemon fin barb was 30% that relates recent findings. The protein prerequisite for *P. hypophthalmus* growth is around 32.5% [14] and 19-30% [15]. According to [16] FCR of commercial feeds ranges between 1.8 to 22, which is more than recent findings. According to [17] a low FCR acts as an indicator of improved consumption of feed. [18] reported best production and survival rate on increasing protein ratios (same as above study) on 30%CP. The average survival rate in recent study varied from 85-98% which lies close to findings of [19]. According to [20] that protein consumption is relatively insignificant and independent of the dietary protein level. As weight gain by fish is connected to the

protein deposition [6]. This justifies the present results, as PER is low with increasing protein levels. Similarly [21] working on *P. hypophthalmus* used commercial feed (29% CP) according to [22] reports that growth increase through gradual increase in crude-protein in diet which lies close to recent work (30%CP).

Morphometric Analysis

The work at *P. hypophthalmus* morphometrics was previously reported by [23]. The phenotypic description of various species involves inter-specific or inter-generic, reasons for morphological description to express incidence of growth allometry [24]. The maximum average values for morphometrics in three of the conducted trials were recorded in 30% CP (T3). As regression analysis (Table 3) and log conversion (Table 4) denotes significant positive relationship of TL towards various morphometric characters is in agreement to findings of [25, 26]. The log values specify the dissimilar body parts grow contrarily as significance level varies among them. As “r” value of all treatments shows highly significant relationship towards log of mostly morphometric variants as reported by [26]. As the recent findings are near to isometric (b=1) values detected for *O. mossambicus* by [27] and for *T. putitora* by [28]. According to

[26] and [29] owing to deviation in breeds, sexes, physio-chemical conditions, alkalinity, season, biogeography, and few abiotic factors effects determining the resultant values of 'b'. The value of $b < 3$, obtained in the present study indicates that the growth of *P. hypophthalmus* follows negative allometric trend. This result is consistent with the findings of [30]. Condition factor (K) for *Pangasius* in the present work (0.83 to 0.88) was less than *C. gibelio* (1.021) but more than *C. capoeta* (0.075) [31]. The lower K-values might be due to less feeding intensity. On the other hand, several studies [32-38] reported a non-significant correlation between TL and K-value. In recent findings K was non-significant $P < 0.05$ in 20% and 25% CP diet but significant of relation between TL and K in 30% CP diet expressing good growth results on recent studies.

CONCLUSION

It is concluded that the artificial protein diet encourages the protein contents that they manage a generous part in growth and development of fish, to made well-balanced healthy feed. FCR of commercial feeds stood high as expressed in 30% T3 diet. Small scale farmers of striped-catfish (*Pangasianodon hypophthalmus*) can have high profit; if they were using commercial-

feeds. In addressing this, the certain commercial feeds had the prospective to be utilized as aqua feeds for striped-catfish besides omnivore-fishes with obvious consequences in growth.

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