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Metabolic Changes Associated with Diverse Protein Concentrates in *Cyprinus Carpio*

Imtisunep[1], Prof. Sharif U. Ahmed[2]
[1,2]Department of Zoology, Nagaland University, Lumami, 798627, India

***Corresponding Author:**
Imtisunep
Email: Imtisunepjune@gmail.com

Abstract: Although the growth and feed performance of the fishes after inclusion of varying doses of proteins, lipids and carbohydrate has been established by so many authors in different classes of fishes. The present research work is based on the protein concentrate variation to assess the growth performance. Inclusion of 25, 30, 35 and 40% crude protein in diet of *Cyprinus carpio* showed promising growth parameters in treatment 4 with 35% CP inclusion. Results revealed that fish meal can be a good choice for better economic returns from the carp culture.
Keywords: *Cyprinus carpio communis*, Crude Protein, FCR, SGR, PER

INTRODUCTION

Aquaculture is the back bone of Fisheries Industry throughout the world. In India fisheries industry contributes 2% to GDP. Focus has been on the innovations and research for development of fisheries sector through physical and feeding management. Since pond management has been an old science, with little innovations being implemented from time to time. A major determinant of successful intensification of aquaculture is feed. It accounts for a major part of the total operation cost of an average fish farm. The performance of a feed is not only dependent on its quality but also on feeding management. Good quality, nutritionally adequate feed can give poor performance unless proper feeding practice (feed allowance, feeding frequency and method, and daily feeding schedules) are employed [23]. Thus, particular attention must be directed towards the development of feeding strategies necessary to obtain economical production and maintain a clean environment.

Aquaculture nutrition research has developed significantly over the past 35 years. More recently attention has also been paid to other important species of fish cultured in different parts of the world, as well as new fish species with aquaculture potential [46]. Aquaculture nutrition has been of immense importance since times immemorial. A lot of research has so far been done on the inclusion and substitution of various proteins and protein products to see their impact on the growth of commercially available fish species. Species specific changes in metabolic and biological profile has been reported by many authors throughout the world, but a proper and nominal protocol has not be devised even after progressive implementation of the research from laboratory to land. A lacunae is still left, which needs further research in nutritional aspects of fisheries science. The present research aims at the inclusion of different crude protein concentrations in feed formula for Common carp, to assess its impact on various physio-biological parameters on early life stages.

MATERIALS AND METHODS

Cyprinus carpio communis fingerlings were procured from the Brooder Fish Farm Half-Nagarjan, Dimapur District, Nagaland. The fingerlings with an average weight of 1.5 g were collected after proper health check up and stocked in glass tanks. In each tank, 30 fingerlings were stocked and the treatment replica was named as per the protein concentrate tested. The composition of the feed formulations is presented in table 1. Following parameters were recorded to asses the growth and feed performance of the *Cyprinus carpio communis* fingerlings fed on formulated diets ($DT_{1(25\%)}$, $DT_{2(30\%)}$, $DT_{3(35\%)}$ and $DT_{4(40\%)}$) with respect to conventional feed ($CTRL_{(20\%)}$) during the experimental period

a) Net Weight Gain (NWG)
Net Weight Gain (g) = Mean final fish weight (g) - Mean initial fish weight (g) [50]

b) Body Weight Gain (%)
Body weight gain (BWG, %) = [(final body weight (g) - initial body weight (g)) /initial body weight (g)] ×100. [8]

c) Average Daily Weight Gain (ADWG)
Average Daily Weight Gain (ADWG) = Wt-Wo/T (days)

d) Average Weekly Weight Gain (AWWG)
Average Weekly Weight Gain (AWWG) = Wt-Wo/T (Weeks)

e) Specific Growth Rate (SGR % / day)
SGR is the average percentage weight change per day between any two weightings provided that the growth curve is exponential in form.
SGR (% / Day) = $[(\ln W_2 - \ln W_1) / (T_2 - T_1)] \times 100$ [16]

Where W_1 is the initial fish weight (g) at time T_1 (day) and W_2 is the final fish weight (g) at time T_2 (day)

f) Feed Conversion Ratio (FCR)
FCR is defined as the feed consumed in dry weight per unit live weight gain.

FCR= Feed consumed (g dry weight) / Live weight gain (g) [16]

g) Feeding Rate
Feeding rate = (Diet consumption / Weight Gain) × No. of days

h) Daily Growth Coefficient
Daily growth coefficient (DGC) = 100 x [(final body weight$^{0.333}$-initial body weight$^{0.333}$)/days of experiment] [11]

i) Thermal Growth Coefficient
Thermal growth coefficient (TGC) = [(final body weight$^{0.333}$-initial body weight$^{0.333}$)/(water temperature x days of experiment]

j) Daily Feed Intake (g $d^{-1}fish^{-1}$)
Daily feed intake (FI, g d− 1fish− 1)= diet consumed × 100 / duration in days /fish number per tank [57]

k) Protein Intake (PI)
This was determined following Sveier *et al.,* (2000) method using the formula:
PI = Total feed intake x % crude protein in the diet.

l) Assimilation
Assimilation = Food consumption/Fecal output

m) Survival (%)
Survival (%) = (Nt/No) x 100 [3]

Study on growth and feed performance of *Cyprinus carpio communis* fingerlings involved assessment of growth and feed performance of fingerlings fed on formulated diets ($DT_{1(25\%)}$, $DT_{2(30\%)}$, $DT_{3(35\%)}$ and $DT_{4(40\%)}$) with respect to conventional feed ($Control_{(20\%)}$). *Cyprinus carpio communis* fingerlings were fed @ 3% of their body weight, three times a day. All the dietary treatments and control were in triplicates. The comprehensive Mean±SD values of different growth parameters are presented in table 1.

After 90 days of each replicate ($R1_{90}$; $R2_{90}$), the average final weight of 5.80g±0.00 was recorded in fingerlings fed on conventional feed. The highest average final weight of 8.40g±0.14 was recorded in DT_3, followed by 7.95g±0.07 in the fingerlings fed on DT_2. The pedigree of final weight in various dietary groups was as $DT_3>DT_2>DT_4>DT_1>CTRL$. Based on the final weight DT_3 was presumed to be the optimum feed with balanced PE ratio for sustained growth of the test fish species. There was no significant difference (P>0.05) in the average final weight of the fingerlings fed on conventional feed and DT_3. Similarly, the net weight gain of 6.87g±0.16 was recorded in DT_3, followed by 6.41g±0.01 in the fingerlings fed on DT_2, which showed similar hierarchal values as those for final weight. Similar trend was reported for mean body weight gain and average daily weight gain.

The Common carp fingerlings showed highest average weekly weight gain of 0.57±0.01 in DT_3, followed by 0.53±0.00 in the fingerlings fed on DT_2, as compared to control (0.36±0.01). There was no significant difference (P>0.05) in the average weekly weight gain of the fingerlings fed on conventional feed and DT_3. In case of specific growth rate (SGR), The highest specific growth rate of 1.89±0.03 was recorded in DT_3, followed by 1.82±0.05 in the fingerlings fed on DT_2, as compared to conventional diet (1.50±0.06).

The mean food conversion ratio of 2.41±0.00 was recorded in fingerlings fed on conventional feed. The lowest FCR of 1.08±0.07 was recorded in DT_3, followed by 1.39±0.00 in the fingerlings fed on DT_2. Fingerlings in DT_4 showed markedly lower food conversion ratio of 1.63±0.02 than DT_1 (1.74±0.09). The findings coincide with the value of SGR. The pedigree of FCR in various dietary groups was as $DT_3<DT_2<DT_4<DT_1<CTRL$. There was no significant difference (P>0.05) in the food conversion ratio of the fingerlings fed on conventional feed and DT_3.

On the other hand, the lowest feeding rate of 0.97±0.06 was recorded in DT_3, followed by 1.25±0.00 in the fingerlings fed on DT_2, as compared to control (2.17±0.00). The pedigree of feeding rate in various dietary groups was as $DT_3<DT_2<DT_4<DT_1<CTRL$. There was no significant difference (P>0.05) in the feeding rate of the fingerlings fed on conventional feed and DT_3. Daily growth coefficient showed a uniform value of 0.01±0.00 for all the treatment groups during the course of study. The pedigree of DGC in various dietary groups was as $DT_3=DT_2=DT_4=DT_1=CTRL$. There was no significant difference (P>0.05) in the feeding rate of the fingerlings fed on conventional feed and DT_3.

At the end of the two experimented replicates ($R1_{90}$; $R2_{90}$), the mean thermal growth coefficient of 0.16±0.22 was recorded in fingerlings fed on conventional feed. All the other diet treatment groups showed the TGC value of 0.31±0.00, corresponding with the values of DGC. The pedigree of TGC in various dietary groups was as DT_3=DT_2=DT_4=DT_1=CTRL. There was no significant difference (P>0.05) in the feeding rate of the fingerlings fed on conventional feed and DT_3. Similarly, the highest daily food intake of 47.10±1.70 was recorded in DT_1, followed by 46.95±1.48 in the fingerlings fed on DT_4. Fingerlings in DT_2 showed markedly higher daily food intake of 46.35±2.33 than DT_3 (46.05±0.64). The pedigree of DFI in various dietary groups was as DT_1>DT_4>DT_2>DT_3>CTRL. There was no significant difference (P>0.05) in the daily food intake of the fingerlings fed on conventional feed and DT_3.

The highest protein intake of 151.62±3.35 was recorded in DT_4, followed by 144.43±4.32 in the fingerlings fed on DT_3. The pedigree of PI in various dietary groups was as DT_4>DT_3>DT_2>DT_1>CTRL. There was no significant difference (P>0.05) in the protein intake of the fingerlings fed on conventional feed and DT_3. Coherently, the fingerlings in DT_3 showed markedly higher faecal output of 41.02±0.18 than DT_1 (38.54±0.58). The pedigree of faecal output in various dietary groups was as DT_4>DT_2>DT_3>DT_1>CTRL. There was no significant difference (P>0.05) in the faecal output of the fingerlings fed on conventional feed and DT_3.

At the end of the two experimented replicates ($R1_{90}$; $R2_{90}$), the mean assimilation of 8.59±0.16 was recorded in fingerlings fed on conventional feed. The highest assimilation of 10.06±0.08 was recorded in DT_3, followed by 9.18±0.13 in the fingerlings fed on DT_2. Fingerlings in DT_1 showed markedly higher assimilation of 8.91±0.25 than DT_4 (8.07±0.09). The pedigree of assimilation in various dietary groups was as DT_3>DT_2>DT_1>DT_4>CTRL. There was no significant difference (P>0.05) in the assimilation of the fingerlings fed on conventional feed and DT_3. The highest survival of 95.00±2.35 was recorded in DT_3, followed by 93.33±0.00 in the fingerlings fed on DT_1. There was no significant difference (P>0.05) in the survival of the fingerlings fed on conventional feed and DT_3.

From table 2, it is clear that final weight (FW) showed negative correlation with FCR (-0.98) and FR (-0.98) while as a positive relation was established with rest of the parameters. Similarly net weight gain (NWG) showed negative relation with FCR (-0.98) and FR (-0.97), while as body weight gain (BWG) showed similar trend with rest of the parameters with negative correlation with FCR (-0.97) and FR (-0.97). Average daily weight gain (ADWG) and Average weekly weight gain (AWWG) showed similar trends with negative correlation with FCR (-0.97; -0.96) and FR (-0.97; -0.97) respectively. Specific growth rate showed positive relation with all the parameters except FCR (-0.98) and FR (-0.97). FCR and FR showed negative correlation with all the parameters. The correlation matrix for DGC could not be calculated because of non variance among the means. Daily food intake (DFI) showed negative correlation with assimilation (-0.20) only, while as faecal output (FO) showed negative relation with assimilation (-0.24). The correlation matrix could easily portray the interlinks between the growth parameters used for assessment of the protein concentrates on growth of *Cyprinus carpio* fingerlings.

Table 1: Overall Mean ± SD of growth and feed performance of *Cyprinus carpio communis* fingerlings fed on conventional feed (Control) and formulated feeds (N = 180D)

Treatment Groups	***Replicas***	***Parameters*** IW (g)	FW (g)	NWG	BWG	ADWG	AWWG	SGR	FCR	Feeding rate	DGC	TGC	DFI gd^{-1} $fish^{-1}$	PI Total (mg/fish)	Faecal Output	Ass.	S%
Ctrl	Mean ±SD	1.51 ±0.08^{a}	5.80 ±0.00^{b}	4.30 ±0.08^{b}	285.90 ±19.95^{a}	0.05 ±0.00^{b}	0.36 ±0.01^{b}	1.50 ±0.06^{a}	2.41 ±0.00^{b}	2.17 ±0.00^{b}	0.01 ±0.00^{a}	0.16 ±0.22^{a}	45.15 ±2.33^{a}	60.42 ±2.50^{c}	35.19 ±0.09^{b}	8.59 ±0.16^{c}	86.60 ±0.00^{a}
DT1	Mean ±SD	1.57 ±0.06^{a}	6.85 ±0.07^{b}	5.28 ±0.13^{a}	336.67 ±20.24^{a}	0.06 ±0.00^{b}	0.44 ±0.01^{a}	1.64 ±0.05^{b}	1.74 ±0.09^{c}	1.56 ±0.08^{a}	0.01 ±0.00^{c}	0.31 ±0.00^{a}	47.10 ±1.70^{b}	85.86 ±3.67^{a}	38.54 ±0.58^{a}	8.91 ±0.25^{b}	93.33 ±0.00^{a}
DT2	Mean ±SD	1.55 ±0.08^{b}	7.95 ±0.07^{a}	6.41 ±0.01^{a}	415.10 ±21.36^{a}	0.07 ±0.00^{b}	0.53 ±0.00^{a}	1.82 ±0.05^{c}	1.39 ±0.00^{b}	1.25 ±0.00^{c}	0.01 ±0.00^{a}	0.31 ±0.00^{c}	46.35 ±2.33^{b}	113.23 ±2.59^{a}	41.08 ±0.13^{c}	9.18 ±0.13^{a}	91.67 ±2.35^{b}
DT3	Mean ±SD	1.54 ±0.02^{a}	8.40 ±0.14^{b}	6.87 ±0.16^{b}	447.35 ±16.78^{a}	0.08 ±0.00^{b}	0.57 ±0.01^{b}	1.89 ±0.03^{a}	1.08 ±0.07^{b}	0.97 ±0.06^{a}	0.01 ±0.00^{c}	0.31 ±0.00^{c}	46.05 ±0.64^{c}	144.43 ±4.32^{a}	41.02 ±0.18^{b}	10.06 ±0.08^{a}	95.00 ±2.35^{b}
DT4	Mean ±SD	1.57 ±0.05^{a}	7.66 ±0.13^{b}	6.09 ±0.08^{b}	389.25 ±6.89^{c}	0.07 ±0.00^{a}	0.51 ±0.01^{b}	1.76 ±0.02^{c}	1.63 ±0.08^{a}	1.47 ±0.07^{c}	0.01 ±0.00^{b}	0.31 ±0.00^{a}	46.95 ±1.48^{c}	151.62 ±3.35^{c}	47.00 ±0.04^{a}	8.07 ±0.09^{b}	88.33 ±2.36^{a}

IW (g) = Initial weight; FW (g) = Final Weight; NWG = Net Weight Gain; BWG = Body Weight Gain; ADWG = Average Daily Weight gain; AWWG = Average Weekly Weight Gain; SGR = Specific Growth Rate; FCR = Food Conversion Ratio; DGC = Daily Growth Coefficient; TGC = Thermal Growth Coefficient; DFI (gd^{-1} $fish^{-1}$) = Daily Feed Intake; PI (mg/fish) = Protein Intake; Ass. = Assimilation; S (%) = Survival

Note: Values are means±SD of three replications (d.f. 4, 9). Means in the same row having different superscripts are significantly different ($P < 0.05$) and values in the same row with same superscript are not significantly different ($P > 0.05$).

Table 2: Correlation matrix of various growth parameters of *Cyprinus carpio communis* fed on four formulated diets with varying crude protein concentration

Parameters	*IW (g)*	*FW (g)*	*NWG*	*BWG*	*ADWG*	*AWWG*	*SGR*	*FCR*	*FR*	*DGC*	*TGC*	*DFI*	*PI*	*FO*	*Ass.*	*S%*
IW (g)	1.00															
FW (g)	0.47	1.00														
NWG	0.44	1.00	1.00													
BWG	0.37	0.99	1.00	1.00												
ADWG	0.41	0.99	0.99	0.99	1.00											
AWWG	0.45	1.00	1.00	1.00	0.99	1.00										
SGR	0.41	1.00	1.00	1.00	0.99	1.00	1.00									
FCR	-0.47	-0.98	-0.98	-0.97	-0.97	-0.97	-0.98	1.00								
FR	-0.47	-0.98	-0.97	-0.97	-0.96	-0.97	-0.97	1.00	1.00							
DGC	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.00						
TGC	0.85	0.83	0.82	0.78	0.78	0.82	0.80	-0.86	-0.86	NA	1.00					
DFI	1.00	0.42	0.40	0.32	0.36	0.41	0.37	-0.44	-0.44	NA	0.84	1.00				
PI	0.52	0.88	0.88	0.86	0.91	0.89	0.87	-0.80	-0.80	NA	0.73	0.47	1.00			
FO	0.69	0.68	0.67	0.63	0.67	0.69	0.65	-0.56	-0.56	NA	0.69	0.64	0.90	1.00		
ASS	-0.20	0.53	0.54	0.58	0.56	0.53	0.57	-0.65	-0.65	NA	0.28	-0.20	0.18	-0.24	1.00	
S%	0.37	0.66	0.66	0.65	0.66	0.65	0.66	-0.80	-0.81	NA	0.71	0.39	0.36	0.07	0.82	1.00

IW (g) = Initial weight; FW (g) = Final Weight; NWG = Net Weight Gain; BWG = Body Weight Gain; ADWG = Average Daily Weight gain; AWWG = Average Weekly Weight Gain; SGR = Specific Growth Rate; FCR = Food Conversion Ratio; FR = Feeding Rate; DGC = Daily Growth Coefficient; TGC = Thermal Growth Coefficient; DFI (gd^{-1} $fish^{-1}$) = Daily Feed Intake; PI (mg/fish) = Protein Intake; FO = Faecal output; Ass. = Assimilation; S (%) = Survival

DISCUSSION

The growth and feed performance of the fishes after inclusion of varying doses of proteins, lipids and carbohydrate has been established by so many authors in different classes of fishes, which include commendable contribution of Noor *et al*. [32] (Silver barb, *Barbodes gonionotus* Bleeker); Hanumanthappa *et al*. [15]; Shoaib *et al.* [40]; Buyukcapar and Kamalak, [10]; Paltenea Elpida *et al*. [33]; Moein *et al*. [28]; Hojatollah Jafaryan *et al*. [17]; Kumar *et al*. [22]; Sudeshna *et al*. [47]; Moein, [27]; Akrami *et al*. [4]; Firas & Ramadan, [14]; Bambroo, [7]; Mohapatra & Patra, [29] (Common carp, *Cyprinus carpio*), Lixin Wu & Dong, [24] (Chinese shrimp, *Fenneropenaeus chinensis*); Abid and Salim, [1]; Kalita *et al*. [21] (*Cirrhinus mrigala*); Wilson *et al*. [56]; Solomon *et al*. [44]; Tonye and Sikoki, [54]; Zeinab *et al*. [58] (Nile tilapia, *Oreochromis niloticus* L.); Sheng Wang, [39]; Zhen-Yu Du *et al*. [59] (*Ctenopharyngodon idella*); Singh *et al*., [41]; Mondal *et al*. [30]; Maity & Patra, [26]; Xue *et al*., [57] (Japanese Sea Bass, *Lateolabrax japonicus*); Umaru, [55]; Adewole & Olaleye, [2]; Tiamiyu *et al*. [53] (*Clarias gariepinus*); Jatuporn Bundit, [20] (The Marble Goby, *Oxyeleotris marmoratus*); Kalita *et al*. [21]; Savita *et al*. [37] (*Catla catla*); Muthukumar & Kandeepan, [31] (*Mystus cavasius*); Radhika *et al*. [35] (*Mollinesia latipinna*); Effiong *et al*. [12] (*Heterobranchus longifilis*); Thepparath Ungsethaphand, [52] (Hybrid red tilapia (*Oreochromis mossambicus* × *O. niloticus*)); Stavros Chatzifotis *et al*. [45] (Meagre, *Argyrosomus regius*); Ta'ati *et al*. [49] (Great sturgeon, *Huso huso*); Tendulkar and Kulkarni, [51] (Banana prawn, *Fenneropenaeus merguiensis* (De Man, 1888)); Arkadios Dimitroglou *et al*. 2011 (Atlantic Salmon (*Salmo salar* L.)); Bhavan and Radhakrishnan, [9] (*Macrobrachiu malcomsonii*); Lone *et al*. [25] (*Tor tor* (Hamilton, 1822)); and Jamali *et al*. [19] (*Oncorhynchus mykiss*).

During the present experiment, the maximum growth was observed in fingerlings fed on $DT_{3\ (35\%)}$ in terms of average final weight (8.50 in replica first and 8.30 in replica second; 8.40 ± 0.14^{b}), NWG (6.98 in replica first and 6.75 in replica second; 6.87 ± 0.16^{b}), BWG (459.21 in replica first and 435.48 in replica second; 447.35 ± 16.78^{a}), ADWG (0.08 in replica first and 0.08 in replica second; 0.08 ± 0.00^{b}), AWWG (0.58 in replica first and 0.56 in replica second; 0.57 ± 0.01^{b}), SGR (1.91 in replica first and 1.86 in replica second; 1.89 ± 0.03^{a}), Daily growth coefficient (0.01 ± 0.00^{c}), Thermal growth coefficient (0.31 ± 0.00^{c}), Daily feed intake (45.60 in replica first and 46.50 in replica second; 46.05 ± 0.64^{c}), Protein Intake (144.01 in replica first and 144.86 in replica second; 144.43 ± 4.32^{a}), Faecal output (41.14 in replica first and 40.89 in replica second; 41.02 ± 0.18^{b}), Assimilation (10.0 in replica first and 10.12 in replica second; 10.06 ± 0.08^{a}) and survival (96.66 in replica first and 93.33 in replica second; 95.00 ± 2.35^{a}), while as two parameters showed minimum values i.e., FCR (1.03 in replica first and 1.13 in replica second; 1.08 ± 0.07^{b}), and Feeding Rate (0.93 in replica first and 1.02 in replica second; 0.97 ± 0.06^{a}), which proved that inclusion of 35% crude protein in diet of Common carp has good growth results.

Erkan *et al*. [13] studied the inclusion of isonitrogenous and isoenergetic (38% crude protein, 15.75 kJ g 100% FM protein in Common carp diet for 13 weeks. Results indicated that final weight, specific growth rate and feed efficiency ratio of fish fed with different SSM replacement diets did not differ significantly ($p > 0.05$) from fish fed the control diet. No significant differences were noted among experimental treatments on dry matter, protein, lipid and ash contents of the fish body composition ($p > 0.05$). The authors focused on sand smelt exclusive inclusion for better growth performance of fish. Common carp (*Cyprinus carpio*) is one of the most widely cultured fish species in the world. The nutritional requirements for growth, reproduction and normal physiological functions of fish are similar to other animals, but generally fish need more proteins in their diet. Due to this, the efficiency in the use and utilization of proteins is more significant for fish than for other animals.

A 90-day feeding experiment was conducted to evaluate the influences of vitamin C (Ascorbic Acid, AA) on growth parameters Common Carp (Cyprinus carpio) by Moein [27]. At the end of the experiment, growth and feeding parameters, carcass composition and survival rate of fries were evaluated using 38% CP. The authors reported that the specific growth rate (SGR), food conversation efficiency (FCE) were increased significantly ($P < 0.05$) and highest SGR was observed. However, no significant differences in survival rate was observed between the treatments ($P < 0.05$).

In yet another trial, a study evaluated the suitability of chicken intestine as an alternate protein source of fish meal for grass carp fry diet by Amtul and Amna [5]. All the diets were designed to contain equivalent levels of -nitrogen -lipids and energy resulting in diets with 35% protein, 10% lipid and 429-431kcal energy per 100g diet. The authors reported higher growth and lowest feed conversion ratio for treatments with higher growth and vice versa. Sivani *et al*. (2013) reported best growth in terms of weight gain (35.2g), specific growth rate (4.67), protein efficiency ratio (PER) (2.7), feed conversion ratio (FCR) (2.5) in Common carp fed with 30% crude protein. The observations by the above authors lends complete support to our findings. Mohapatra and Patra [29] lends support to our findings who observed highest total weight gain (9.48±0.47) body weight gain

(578.04±2.74) growth rate (g/day) (0.079±0.03) in Common carp fed with diets containing 34% CP. Studies by Jahan *et al*. [18] have revealed an increase in final weight, average live weight gain, specific growth rate (SGR), lower food conversion ratio (FCR), protein efficacy ratio (PER) and apparent net protein utilization (ANPU%) and survival of fingerlings of *Labeo rohita* fed on 28% CP, a soybean meal based diet. Carcass composition also revealed high protein and lipid in fish fed on the same protein diet.

Peyman *et al*. [34] reported the significantly higher (P<0.05) values for final weight, weigh gain rate (WGR%), specific growth rate (SGR), food conversion ratio (FCR) and protein efficiency rate (PER) in Common carp fingerlings fed with diets containing 30%±0.8 crude protein. Similarly, the nutritional value of feeding *Cyprinus carpio* with various levels of raw watermelon seed meal was evaluated by Tiamiyu *et al*. [53]. Five diets of 35% crude protein were formulated with different levels of raw seed meal at 0%, 5%, 10%, 15% and 20% inclusion. The results revealed best mean weight gain, feed conversion ratio, feed conversion efficiency, protein efficiency ratio, apparent net protein utilization, specific growth rate and survival rate. The authors lend complete support to our findings.

The work of Rahman *et al*. [36] contradicts with the present findings in the crude protein inclusion versus the growth rate. The authors reported better growth in *Cyprinus carpio* fingerlings (Av. Wt. (g) = 14.54±2.02) fed with food containing 45.64%±1.47. However authors reported a decreasing trend in growth after inclusion of 48.10%±1.75 crude protein, which supports our findings of inclusion of 40% CP showing retarded growth coefficients. Effect of dietary probiotics supplementation on growth performance of Rohu, *Labeo rohita* fingerlings was carried out by Sayanti *et al*. [38], who reported highest growth performance and feed utilization efficiencies in fishes with protein inclusion levels of 36%, which completely supports our findings. Tiamiyu *et al*. [53] reported highest mean weight gain, specific growth rate, protein efficiency ratio in DT2 (CP = 35.14%) while lower values were recorded in DT5 (CP = 34.73%). Zeinab *et al.* [58] used 37.58% CP in the basal diet to evaluate effect of *Spirulina platensis* and *Lactobacillus rhamnosus* on growth and biochemical performance of Nile Tilapia (*Oreochromis niloticus*) fingerlings. The authors reported highest Average daily gain (0.48), Weight gain (20.16) and SGR (0.33) in test fishes with inclusion level of 37.58% CP, which more or less supports our findings.

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