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Effect of varying dietary protein levels on length-weight relationships and length-length relationships of hybrid (*Labeo rohita* ♀x *Catla catla* ♂) from Multan, southern Punjab, Pakistan

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Abstract: Present study was conducted to analyses length-weight relationships and external morphometric parameters of hybrid (*Catla catla*♂ x *Labeo rohita*♀) fed with three graded protein diets as T1 (15%), T2 (20%) and T3 (25%), in hapas (8x6x3 ft.), at the rate of 5% of their wet body weight. Ten samples from each treatment hapa were randomly selected at the end of 90 days feeding trial for study of length weight relationships and morphometric analysis. T3 (25%) feed showed highest values of mean wet weight, total length, and all other morphometric characters than T1 (15%) and T2 (20%) feeds. Regression analysis confirmed in LWRs (Length Weight Relationships) that "b" value in all (T1=2.698, T2=2.846, T3=2.993) feeds was less than 3 showing negative allometric growth. Condition factor values in all (T1=2.37, T2=2.40, T3=2.86) feeds represent an increasing trend with increasing dietary protein levels observed good health condition of fish. Analysis of log total length and log wet body weight confirmed positive correlation with different external morphometric parameters in all (T1, T2, T3) feeds. ANOVA results showed significant difference among different treatments in all morphometric parameters of hybrid. T-test results observed that mean values of different morphometric parameters in T3 (P<0.001) was found to be higher from T1 and T2.

Keywords: Morphometry, hybrid fry, hapa, protein diets, LWR

1. INTRODUCTION

In Aquaculture, choice of a fish species for culturing requires knowledge of its size and impact of feeding on it (Kuebutornye, *et al.*, 2019). Morphometric parameters are used to identify, classify fishes and to evaluate the isometric and allometric growth pattern (Naeem *et al.*, 2012).

Successful fish culture required mass fish production within short time, so there is always a need of balanced diet which produce healthy and quality products within limited time. Protein content in feed enhances growth in fish body (Mzengereza *et al.*, 2016). Mostly farmers use animal protein sources such as fish meal and fish oil in preparation of fish feed which are costly, so there is a need to educate farmers about plant origin ingredients which are less costly and easily available (Ishtiaq and Naeem, 2019).

Deep body of *Catla catla* and narrow head of *Labeo rohita* are ideal morphometric characters which can be gained in same fish by hybridization. Ideal characters of fish in aquaculture are narrow head, deep, broader and thicker body and stouter caudal peduncle which enhance edible flesh in fish body (Basavaraju *et al*., 1995). Growth level and health condition of a fish can be determined by analyzing length-weight relationships and condition factor (Zamani, *et al.*, 2015). So, present study was conducted to analyses length-weight relationships and external morphometric parameters variation by providing three graded protein diets to hybrid, which are prepared by using cheaper and locally available feed ingredients

2. MATERIALS AND METHODS

Experimental Layout and Feed preparation

Hybrid (*Catla catla*♂ x *Labeo rohita*♀) fry which were obtained from Tawakkal Fish Hatchery, Tawakal Nagar, Muzaffar Garh Punjab, Pakistan, kept in hapas (8X6X3ft.) in earthen ponds for 90 days, and feed was given at the rate of 5% of their body weight. Hybrid fry were stocked randomly in each hapa at the rate of 75 fish per hapa (150 for each treatment). The water level in the pond was maintained at 3-4 feet during the entire experimental period. For each treatment group, there were two replicates. Three crude protein diets were prepared from cheaper and locally available feed ingredients. The most important ingredients were: wheat brawn, fish meal, rice polishing and sunflower meal etc. Thorough mixing of weighted quantities of all the feed components was done and finally ground to powder form for its easy ingestion. Prepared diet was stored in polythene bags throughout the experimental duration.

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Morphometric Analysis:

After completion of 90 days trial, killing of fishes was done by hitting on their head and blotted dry on a paper towel before measuring length-weight. An electronic balance (Chyo MP-3000) and measuring ruler was used to measure external morphometric parameters. Total Length was measured as a length from tip of snout to the longest part of caudal blade. Standard Length (SL) was taken from tip of snout to the base of caudal fin. Fork Length (FL) was a length from tip of snout to the point where caudal fin is bifurcated and Head Length (HL) was a length from tip of nose to the back end of opercular membrane. Condition factor of each fish sample was calculated by using following formula,

$$K=W/L^3 \text{ X } 100$$

Statistical analysis

Microsoft EXCEL was used for regression analysis. The following equation was used to analyse length-weight relationship and external morphometric parameters relationship with total length and weight.

$$Y=a+b\ X$$

Intercept is "a", slope or coefficient is "b" in regression analysis, "X" can be total length and wet body weight and "Y" can be any morphometric parameter.

Data analysis was performed by using ANOVA to determine any significant differences among morphometric parameters and t-test was applied to check the differences between treatment means only in case of significant difference (ANOVA, $p< 0.05$)**.**

3. RESULTS

The mean, ranges and standard deviation values of various external morphometric parameters of the hybrid raised in all three feed levels are given in **(Table 1).**

Relationship of total length and wet body weight

Analysis of relationship between log-transformed data of total length against wet body weight of the hybrid revealed that all three feed levels had highly significant correlations **(Table 2).** A comparison of "b" value with 3 showed that all three (T1, T2, T3) feed groups had negative allometry because the value was less than "3" in all feed groups.

Table 1: Mean ± S.D. values of different parameters with ANOVA and t-test comparison in hybrid (*L. rohita x C. catla)* (*n* = 10).

Treatment groups	T1=15% crude proteins		T2=20% crude proteins		T3 =25% crude proteins		ANOVA *P* value
Body Measurements	Mean ± S.D.	Range	Mean ± S.D.	Range	Mean ± S.D.	Range	
Body weight (g)	10.60±2.01^{bc}	7.00-12.00	14.60±4.67^{bc}	8.10-20.00	23.80±2.25^{c}	22.00-27.00	0.000***
Total length (cm)	7.37±0.81^{bc}	6.00-8.10	8.16±0.63^{bc}	7.20-9.10	9.44±0.69c	9.00-11.00	0.000***
Condition factor (K)	2.37±0.38^{ab}	1.95-2.95	2.40±0.27^{ab}	1.99-2.73	2.86±0.33^{b}	2.03-3.05	0.004**
Standard length (cm)	6.43±0.50^{ac}	5.80-6.90	6.89±0.51^{ac}	6.10-7.70	7.92±0.67^{c}	7.40-9.40	0.000***
Fork length (cm)	6.74±0.49^{bc}	6.10-7.20	7.23±0.50^{bc}	6.50-8.00	8.36±0.69^{c}	7.90-9.90	0.000***
Head length (cm)	1.67±0.16^{bc}	1.50-1.90	1.94±0.22^{bc}	1.60-2.30	2.40±0.07^{c}	2.30-2.50	0.000***
Eye diameter (cm)	0.21±0.09^{bc}	0.10-0.40	0.33±0.07^{b}	0.20-0.40	0.41±0.03^{bc}	0.40-0.50	0.000***
Body girth (cm)	3.06±0.99^{ab}	2.00-4.00	2.94±1.06^{ab}	2.00-4.60	4.32±0.27^{b}	4.00-4.80	0.002**
Dorsal fin length (cm)	1.14±0.10^{bc}	1.00-1.30	1.23±0.09^{bc}	1.10-1.40	1.40±0.05^{c}	1.30-1.50	0.000***
Body depth (cm)	1.53±0.50^{ab}	1.00-2.00	1.47±0.53^{ab}	1.00-2.30	2.16±0.13^{b}	2.00-2.40	0.002**
Pectoral fin length(cm)	0.96±0.12^{ac}	0.70-1.10	1.01±0.19^{ac}	0.70-1.40	1.46±0.14^{c}	1.30-1.70	0.000***
Pelvic fin length(cm)	0.77±0.21^{ac}	0.40-1.00	0.92±0.14^{ac}	0.70-1.20	1.21±0.13^{c}	1.10-1.50	0.000***
Anal fin length (cm)	0.73±0.18^{bc}	0.40-1.00	0.89±0.15^{bc}	0.60-1.10	1.14±0.07^{c}	1.10-1.30	0.000***
Caudal fin height (cm)	1.66±0.32^{bc}	1.10-2.00	1.97±0.31^{bc}	1.70-2.80	2.57±0.22^{c}	2.30-2.80	0.000***

S.D = Standard Deviation

Table 2: Regression analysis values data between body length and wet body weight and K (condition factor) for the hybrid (*Labeo x Catla*) fish.

Equation	Treatment Groups	Regression Parameters a	b	95% CI of a	95% CI of b	r	r^2
W = a + b TL	**T1 (15%)**	-10.281	2.698	-19.872- -0.689	1.403-3.992	0.862**	0.743
	T2 (20%)	-10.223	2.846	-20.777-0.331	1.556-4.136	0.874***	0.764
	T3 (25%)	-4.450	2.993	-14.328-5.428	1.949-4.036	0.919***	0.845
Log W = a + b Log TL	**T1 (15%)**	-1.224	2.530	-2.124- -0.325	1.492-3.568	0.893***	0.798
	T2 (20%)	-0.668	1.951	-1.472-0.137	1.068-2.834	0.874***	0.764
	T3 (25%)	0.195	1.212	-0.195-0.584	0.812-1.612	0.927***	0.859
Log K = a + b Log TL	**T1 (15%)**	0.776	-0.470	-0.124-1.675	-1.508-0.568	0.346^{ns}	0.120
	T2 (20%)	1.332	-1.049	0.528-2.137	-1.932- -0.164	0.696*	0.480
	T3 (25%)	2.195	-1.788	1.805-2.584	-2.188- -1.388	0.964***	0.930
Log K = a + b Log W	**T1 (15%)**	0.317	0.054	-0.061-0.695	-0.334-0.442	0.113^{ns}	0.013
	T2 (20%)	0.571	-0.175	-0.020-1.162	-0.707-0.357	0.260^{ns}	0.061
	T3 (25%)	2.003	-1.127	1.038-2.968	-1.829- -0.426	0.795**	0.632

Relationship of condition factor with total length and wet body weight

Relationship of condition factor with total length of hybrid showed that T1 (15%) feed had non significant correlation, T2 (20%) feed least significant correlation and T3 (25%) feed highly significant correlations (Table 2). Values of "K" against wet body weight, exhibited non significant correlations in T1 (15%) and T2 (20%) feeds while T3 (25%) feed showed significant correlation **(Table 2).**

Relationship of total length and wet body weight with length of external morphometric parameters. Analysis of total length and wet body weight with SL (standard length) and FL (fork length) confirmed that T1 (15%) feed showed significant correlation, while T2 (20%) and T3 (25%) feeds showed highly significant correlations (Table 3, 4). Observation of HL (head length) with total length and wet body weight of fish revealed that T1 (15%) feed showed least significant relation with total length and significant with body weight, T3 (25%) feed showed least significant correlations in both cases, while T2 (20%) feed observed highly significant correlation **(Table 3, 4).** Relationship of ED (eye diameter) against total length confirmed significant correlations in all (T1, T2, T3) feeds, while with body weight T1 (15%) and T3 (25%) feeds observed least significant correlations and T2 (20%) observed significant correlation (Table 3, 4). Relationship of total length and body weight against BG (body girth), BD (body depth) and DFL (dorsal fin length) observed that T1 (15%) feed showed highly significant correlation, T2 (20%) feed showed significant correlation and T3 (25%) feed observed least significant correlation but non significant in case of DFL with body weight (Table 3, 4). When total length and body weight was plotted against PtFL (pectoral fin length), T1 (15%) feed showed highly significant correlation with total length and no relation with body weight, T2 (20%) feed showed non significant correlation and T3 (25%) feed showed significant correlation (Table 3, 4). When total length and body weight was analysed against PvFL (pelvic fin length), T1 (15%) showed highly significant correlation with total length and least significant with body weight, T3 (25%) and T2 (20%) feed showed highly significant and least significant correlation, respectively (Table 3, 4). Analysis of total length and body weight against AFL (anal fin length), exhibited significant correlation with total length and no relation with body weight in hybrid fed T1 (15%) feed. However, T2 (20%) and T3 (25%) fed hybrid showed non significant and highly significant correlation (Table 3, 4). Relationship of total length and body weight against CFH (caudal fin height) observed that T1 (15%) feed showed highly significant correlation with total length and least significant with wet body weight, while correlation was least significant and non significant for T2 (20%) and T3 (25%) feed **(Table 3,4).**

Table 3: Regression analysis data concerning total length (log-transformed values) and log-transformed values of various morphometric parameters for hybrid (*Labeo x Catla*) fish.

Equation	Treatment Groups	Relationship Parameters		95% CI of a	95% CI Of b	r	r^2
		a	b				
Log SL =a + b Log TL	**T1 (15%)**	0.335	0.546	0.043-0.626	0.210-0.883	0.798**	0.637
	T2 (20%)	-0.028	0.950	-0.121-0.066	0.847-1.053	0.991***	0.983
	T3 (25%)	-0.224	1.151	-0.333- -0.115	1.039-1.263	0.993***	0.986
Log FL = a + b Log TL	**T1 (15%)**	0.358	0.543	0.121-0.595	0.270-0.817	0.851**	0.724
	T2 (20%)	0.047	0.891	-0.022-0.116	0.815-0.967	0.995***	0.989
	T3 (25%)	-0.175	1.125	-0.263- -0.087	1.035-1.216	0.995***	0.990
Log HL = a + b Log TL	**T1 (15%)**	-0.266	0.563	-0.666-0.134	0.101-1.025	0.705*	0.497
	T2 (20%)	-0.987	1.397	-1.278- -0.697	1.079-1.716	0.963***	0.927
	T3 (25%)	0.104	0.284	-0.116-0.323	0.058-0.509	0.716*	0.513
Log ED = a + b Log TL	**T1 (15%)**	-3.427	3.140	-4.704- -2.150	1.666-4.613	0.867**	0.751
	T2 (20%)	-2.726	2.455	-3.817- -1.635	1.258-3.653	0.858**	0.736
	T3 (25%)	-1.148	0.781	-1.651- -0.646	0.264-1.297	0.777**	0.603
Log BG = a + b Log TL	**T1 (15%)**	-1.727	2.533	-2.721- -0.732	1.385-3.681	0.874***	0.764
	T2 (20%)	-2.773	3.534	-4.839- -0.707	1.266-5.801	0.786**	0.617
	T3 (25%)	0.040	0.610	-0.471-0.552	0.086-1.135	0.688*	0.473
Log DFL = a + bLog TL	**T1 (15%)**	-0.552	0.702	-0.707- -0.397	0.523-0.881	0.954***	0.911
	T2 (20%)	-0.645	0.806	-1.079- -0.211	0.330-1.283	0.810**	0.656
	T3 (25%)	-0.163	0.317	-0.450-0.124	0.023-0.612	0.660*	0.436
Log BD = a + b Log TL	**T1 (15%)**	-2.028	2.533	-3.022- -1.033	1.385-3.681	0.874***	0.764
	T2 (20%)	-3.074	3.534	-5.141- -1.008	1.266-5.801	0.786**	0.617
	T3 (25%)	-0.261	0.610	-0.772-0.251	0.086-1.135	0.688*	0.473
LogPtFL= a + b Log TL	**T1 (15%)**	-0.912	1.030	-1.282- -0.542	0.603-1.458	0.891***	0.794
	T2 (20%)	-1.120	1.227	-2.713-0.474	-0.522-2.976	0.496^{ns}	0.246
	T3 (25%)	1.190	-0.997	-1.560- -0.434	0.613-1.768	0.859**	0.738
LogPvFL= a + b Log TL	**T1 (15%)**	-2.392	2.613	-3.191- -1.592	1.690-3.536	0.918***	0.842
	T2 (20%)	-1.248	1.326	-2.316- -0.180	0.153-2.498	0.678*	0.459
	T3 (25%)	-1.255	1.371	-1.619- -0.890	0.997-1.745	0.948***	0.899
Log AFL= a + b Log TL	**T1 (15%)**	-1.786	1.891	-2.822- -0.751	0.696-3.086	0.790**	0.625
	T2 (20%)	-1.183	1.237	-2.707-0.341	-0.436-2.909	0.516^{ns}	0.266
	T3 (25%)	-0.761	0.839	-0.813- -0.708	0.785-0.893	0.997***	0.994
Log CFH= a + b Log TL	**T1 (15%)**	-1.358	1.815	-1.650- -1.066	1.478-2.152	0.975***	0.951
	T2 (20%)	-0.874	1.279	-1.841-0.093	0.218-2.340	0.701*	0.491
	T3 (25%)	-0.285	0.712	-1.071-0.501	-0.094-1.519	0.584^{ns}	0.341

Corrélation coefficient (r), r^2: coefficient of determination, intercept (a), regression coefficient (b), Cl: confidence intervals, *** $p < 0.001$, ** $p < 0.01$

Table 4: Regression analysis data related to the hybrid (*Labeo x Catla*) log-transformed values of weight in gm and log-transformed values of different morphometrics parameters.

Equation	Treatment Groups	Relationship Parameters		95% CI of a	95% CI Of b	r	r^2
		a	b				
Log SL = a + b Log W	**T1 (15%)**	0.350	0.618	0.095-0.605	0.273-0.962	0.825**	0.681
	T2 (20%)	0.384	0.577	0.327-0.441	0.504-0.649	0.988***	0.977
	T3 (25%)	0.155	0.848	0.004-0.306	0.676-1.020	0.970***	0.942
Log FL = a + b Log W	**T1 (15%)**	0.400	0.578	0.163-0.637	0.259-0.898	0.828**	0.685
	T2 (20%)	0.432	0.543	0.399-0.465	0.500-0.585	0.995***	0.991
	T3 (25%)	0.193	0.831	0.058-0.329	0.676-0.985	0.975***	0.951
Log HL = a + b Log W	**T1 (15%)**	-0.342	0.761	-0.601- -0.082	0.411-1.110	0.871**	0.759
	T2 (20%)	-0.393	0.863	-0.514- -0.272	0.709-1.017	0.977***	0.955
	T3 (25%)	0.195	0.211	0.045-0.346	0.039-0.383	0.707*	0.500
Log ED = a + b Log W	**T1 (15%)**	-2.909	2.971	-4.492- -1.326	0.834-5.107	0.750*	0.562
	T2 (20%)	-1.679	1.512	-2.233- -1.124	0.808-2.217	0.868**	0.754
	T3 (25%)	-0.869	0.549	-1.242- -0.496	0.123-0.974	0.724*	0.525
Log BG = a + b Log W	**T1 (15%)**	-1.822	3.090	-2.245- -1.398	2.519-3.661	0.975***	0.951
	T2 (20%)	-1.285	2.201	-2.330- -0.241	0.875-3.528	0.804**	0.647
	T3 (25%)	0.237	0.454	-0.113-0.588	0.053-0.854	0.679*	0.461
Log DFL = a + bLog W	**T1 (15%)**	-0.492	0.740	-0.682- -0.302	0.484-0.996	0.920***	0.847
	T2 (20%)	-0.315	0.514	-0.521- -0.109	0.253-0.776	0.849**	0.720
	T3 (25%)	-0.049	0.223	-0.253-0.155	-0.010-0.456	0.615^{ns}	0.378
Log BD = a + b Log W	**T1 (15%)**	-2.123	3.090	-2.546- -1.699	2.519-3.681	0.975***	0.951
	T2 (20%)	-1.587	2.201	-2.631- -0.542	0.875-3.528	0.804**	0.647
	T3 (25%)	-0.064	0.454	-0.414-0.287	0.053-0.854	0.679*	0.461
Log PtFL= a + b Log W	**T1 (15%)**	-0.597	0.778	-1.198-0.005	-0.034-1.590	0.616^{ns}	0.379
	T2 (20%)	-0.618	0.782	-1.442-0.207	-0.265-1.830	0.520^{ns}	0.271
	T3 (25%)	-0.600	0.871	-1.011- -0.189	0.402-1.340	0.834**	0.696
Log PvFL= a + b Log W	**T1 (15%)**	-1.588	1.969	-3.046- -0.131	0.002-3.935	0.632*	0.400
	T2 (20%)	-0.678	0.811	-1.238- -0.119	0.101-1.522	0.681*	0.464
	T3 (25%)	-0.800	1.006	-1.099- -0.501	0.665-1.347	0.923***	0.852
Log AFL= a + b Log W	**T1 (15%)**	-1.244	1.478	-2.548-0.060	-0.282-3.238	0.565^{ns}	0.319
	T2 (20%)	-0.643	0.746	-1.447-0.161	-0.275-1.767	0.512^{ns}	0.262
	T3 (25%)	-0.486	0.619	-0.584- -0.388	0.507-0.730	0.976***	0.953
Log CFH= a + b Log W	**T1 (15%)**	-0.935	1.551	-1.732- -0.139	0.476-2.626	0.762*	0.581
	T2 (20%)	-0.335	0.795	-0.832-0.163	0.164-1.427	0.716*	0.513
	T3 (25%)	-0.060	0.535	-0.594-0.474	-0.074-1.144	0.582^{ns}	0.339

Correlation coefficient (r), r^2: coefficient of determination, intercept (a), regression coefficient (b), Cl: confidence intervals, *** $p < 0.001$, ** $p < 0.01$

ANOVA and t-test results Significant difference among different treatments was found in all morphometric parameters of hybrid. Mean values of different morphometric parameters of hybrid in T3 was found to be higher from T1 and T2 highly significantly (P<0.001).

4. DISCUSSION

Analysis of mean values of different morphometric parameters confirmed that hybrid showed highest mean values of different morphometric parameters in fish fed with T3 (25%) feed as compared to T1 (15%) and T2 (20%) feeds (Table 1). These findings are similar to the results of Iqbal and Naeem (2018) on *Labeo rohita* which also showed highest values at 25% protein feed, but contrary to Malik and Naeem (2020) which observed best results at 30% protein feed.

Relationship of total length and wet body weight

Relationship of total length with wet body weight in present study showed highly significant correlations in T2 (20%) and T3 (25%) feeds showed in Table 2

similar to the results of many researchers (Khalid and Naeem, 2017; Iqbal and Naeem, 2018). Highest value of "r" representing good health condition of fish (Narejo, 2006). The value of "b" represent growth trend as it is isometric (b=3.0), positive allometric growth (b>3.0) and negative allometric growth (b<3.0). When value of "b" was compared with 3 in length weight relationships, it was confirmed that in all (T1, T2, T3) feeds the value is less than 3 showing negative allometric growth similar to the findings of many researchers (Balai *et al*., 2017; Konan *et al.*, 2017). Present study values of "b" in all feeds (T1=2.698, T2=2.846, T3=2.993) is in normal range for fish (2.4-4.0 according to Martin, (1949). Many factors influenced the value of "b" as seasons and time of the year, temperature, salinity, sex, stage of maturity (larval, immature, mature), quantity, quality and size of feed and can be feed ingredients used in fish feed, even with daily changes in habitats can cause variation in "b" value as compared to "a" value which is more constant (Yeasmin *et al*., 2015).

Relationship of condition factor with total length and wet body weight

In present study, average value of condition factor in all feeds (T1=2.37, T2=2.40, T3=2.86) is above 2 similar to the ranges given by many researchers (Konan *et al.*, 2017). Condition factor remained constant with increasing wet body weight in T1 (15%) and T2 (20%) feed similar to the findings of many researchers (Naeem *et al.*, 2011; Iqbal and Naeem, 2018) and highly significant correlation in T3 (25%) representing good health condition of fish similar to conclusions of many investigators (Narejo *et al.*, 2006; Isa *et al.*, 2010). Condition factor remained insignificant with total length represent in T1 (15%) feed similar to the results of Naeem *et al.* (2012), while T2 (20%) feed showed least significant and T3 (25%) feed reported highly significant correlation similar to the findings of Naeem *et al.* (2011). Fish which are heavy mostly have higher "K" value as compared to lighter fish with respect of their lengths (Wootton, 1998). Many factors can influenced value of condition factor in fish as age, physiological state of fish, environmental factors, reproductive cycle and feeding ingredients (Narejo *et al*., 2002).

Relationship of total length with length of external morphometric parameters

Analysis of log total length with all external log morphometric concluded that T1 (15%) feed showed highly significant correlations with BG, DFL, BD, PtFL, PvFL and CFH, T2 (20%) feed showed highly significant correlation with SL, FL, HL and T3 (25%) feed showed highly significant correlation with SL, FL , PvFL and AFL similar to the findings of many researchers (Naeem *et al*., 2011; Khalid and Naeem, 2017). All morphometric parameters are positively correlated to log total length (Table 3) similar to the findings of Khalid and Naeem (2017). When log transformed total length was analysed against all morphometric parameters, it was concluded that value of "b" exhibit positive allometry (b>1), negative allometry (b<1) and isometry (b=1) shown in Table 3 in different parameters in different feeds.

Relationship of wet body weight with length of external morphometric parameters

Analysis of log wet body weight against different morphometric parameters in different feeds as in T1 (15%) feed BD, BG and DFL in T2 (20%) feed SL, FL and HL and in T3 (25%) feed FL, PvFL and AFL showed highly significant correlation similar to the findings of Khalid and Naeem (2017) in grass carp and Iqbal and Naeem, (2018) in *Labeo rohita*. When log transformed wet body weight values were analysed against all morphometric parameters, they showed positive allometry in all (T1, T2, T3) feeds except in HL and DFL in T3 (25%) feed exhibit negative allometry when "b" value was compared with 0.33 shown in Table 4. Variation in morphometric characters in same species can also be attributed to the changing feeding and prey types, temperature of habitat, turbidity and water depth and flow (Turan, 2005).

5. CONCLUSION

The present study revealed that T3 fish group of the hybrid gained more length and weight as compared to the T1 and T2. Morphometric parameters were positively correlated with total length and wet body weight of the hybrids in all studied feed groups.

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