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The length- weight relationship and condition factor of Indian major carp *Labeo rohita* (Hamilton 1822) under culture conditions

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Abstract
Study was conducted for 120 days to observe the efficacy of different doses of spent wash as fertilizer on growth of *Labeo rohita* fingerlings in terms of length-weight relationship and condition factor. Six experimental treatments (T1 to T5) were prepared by using different dosage of distillery waste- spent wash and T_6 was raw cow dong as fertilizer followed by a control without any fertilizer. Maximum average final body weight (60.20g) and specific growth rate (1.63) were recorded with treatment (T6) having raw cow dong as fertilizer followed by T_5 (59.86 and SGR 1.62). The value of exponential 'b' and the condition factor 'K' was in the range of 2.56 to 2.91 and 1.86 – 2.31 respectively in all treatments indicated robustness or well-being of fish.

Keywords: Length-weight relationship, fish growth, fertilizer, distillery waste, condition factor, spent wash

Introduction

Fish play an important role in human nutrition. Good and adequate nutrition plays a very important role in the expression of mental, physical and intellectual qualities in humans. To ensure access to the nutritionally adequate food for the improvement in the quality of diet of a poor person in the society, fish can serve the very purpose because they have the ability to reduce blood lipid level, particularly serum triglycerides and also due to their therapeutic role in reducing certain cardiovascular disorders (Stickney and Hardy, 1989; Ahmed, 2011) [18, 1].
The morphometric relationship between length and weight of fish is a suitable index for understanding growth, survival, maturity, reproduction, general well-being and enables conversion of one variable to other which has vital importance in fish culture. The application of length weight relationship (LWR) could also provide simple alternative to estimate body weight from length measurements that are less variable and more easily measured in the field. Relationships that allow interconversions among the various length and weight parameters are needed to compare growth parameters. The condition factor (K) of a fish reflects physical and biological characteristics and fluctuations by interaction among feeding conditions, parasitic infections and physiological factors (LeCren, 1951) [11] along with assessment of fish condition (Lambert and Dutil, 1997) [10] based on weight at a given length (indicating energy reserves in fish). This also indicates the changes in food reserves and therefore an indicator of the general fish condition. Moreover, body condition provides an alternative to the expensive *in vitro* proximate analysis of tissues (Sutton *et al.*, 2000) [19]. Therefore, information on condition factor can be vital to culture system management because they provide the producer with information of the specific condition under which organisms are developing (Araneda *et al*, 2008) [4].
The Indian major carp, *L. rohita* (Hamilton, 1822), commonly known as 'Rohu' is a geographically widespread species in tropical freshwater of India and adjacent countries, Rohu is the most important among the three Indian major carp species used in carp polyculture systems. This graceful Indo-Gangetic riverine species is the natural inhabitant of the riverine system of northern and central India, and the rivers of Pakistan, Bangladesh and Myanmar. In India, it has been transplanted into almost all riverine systems including the freshwaters of Andaman, where its population has successfully established. The species has also been introduced in many other countries, including Sri Lanka, the former USSR, Japan, China, Philippines, Malaysia, Nepal and some countries of Africa. The traditional culture of this carp goes back hundreds of years in the small ponds of the eastern Indian states.

Information on its culture is available only from the early part of the 20th century. Rohu culture contributes to about 35% of the total Indian major carp production (FAO, 2001) [6]. Moreover, it is very popular and highly priced fish due to its high digestibility, palatability, medicinal and nutritive value, taste and low fat. Though a good deal of work has been carried out on different aspects of survival and growth of rohu in natural habitats (Ujjania *et al.*, 2012*:* Pawar and Supugade, 2017: Naz *et al*., 2013) [20, 16, 13]. However, limited studies are conducted on growth and culture potentiality of this species in terms of length-weight relationship (LWR) and condition factor (K) under captive conditions. To the best of our knowledge, no previous reports on length-weight relationship on this fish species under culture conditions is available. This study will provides a baseline data on this food fish, which may be important basic tool for management and culture practices. Therefore, the present work has been carried out to reach at appropriate fertilization management strategy in context to both these parameters for *L. rohita* fingerlings under captive conditions.

Materials and Methods

Experimental fish and design

The experiment was carried out for 120 days in FRP pools (300 L capacity with 250 L water). The BMC water was used for initial filling of all the pools and to compensate for losses (due to evaporation). Each pool was stocked with advanced fingerlings ((10.20 ± 0.03-10.50 ± 0.25g) of *L. rohita* @ 12/pool. Each treatment was having triplicates.

Experimental treatments

There were seven treatments (Table 1), $T_1 – T_5$ with different concentrations of spent wash, T_6 with raw cow dung @ 10,000 kg/ha/year and a control without fertilizer. Spent wash was collected from K. M. sugar mill and distillery, Ayodhya, Uttar Pradesh, India.

Table 1: Different concentration of fertilizers in different treatments

S. No.	Treatments	Concentration
1.	Control	No fertilizer
2.	T_1	0.5ml spent wash/L water
3	T_2	1ml spent wash/L water
4.	T_3	1.5ml spent wash/L water
5.	T_4	2.0ml spent wash/L water
6.	T_5	2.5ml spent wash/L water
7.	T_6	Cow dung @ 10,000 kg/ha

Feeding of fish

Fish were fed with Commercial carp diet (Grovels India Ltd) @ 3% of body weight twice a day throughout the culture period. The feed quantity was regulated based on the fortnightly sampling of experimental fish.

Water quality analysis

Water quality parameters (temperature, pH, dissolved oxygen, total alkalinity, ammonical - nitrogen, nitrite - nitrogen), nutrient status (nitrate - nitrogen), BOD (biological oxygen demand), COD (chemical oxygen demand) were recorded at fortnightly intervals throughout the experiment according to APHA (2005) [2].

Growth analysis

Fish were measured in terms of weight gain and increase in length. Total length was measured to the nearest 0.1 mm using a 30 cm ruler as the distance from the tip of the anterior most part of the body to the tip of the caudal fin. Analytical balance with precision of 0.01 g was used to record wet body weight. Following growth parameters were calculated.

i. Specific growth rate (SGR) = $\frac{\text{In final body wt - In initial body wt.}}{\text{Culture period (days)}}$ x100

Weight was recorded in gram

ii. Length-weight relationship: The length-weight (log-transformed) relationships were determined by linear regression analysis and scatter diagrams of length and weight. The length-weight relationship of the experimented fish is worked out as per cube law given by Le Cren (1951) [11].

$$W = aL^b$$

Where, W = Weight of fish (g), L is Total length (cm), ‘a’ is the regression intercept and ‘b’ is the Regression slope.

The logarithmic transformation of the above formula is-

$$\text{Log } W = \log a + b \log L$$

iii. Fulton’s condition factor (K): Fulton’s condition factor (K) was calculated according to Htun-Han (1978) equation as per formula given below:

$$K = W/L^3 \text{ x100}$$

Where, W = Weight of fish (g), L = Length of fish (cm).

Statistical analysis

One way ANOVA was applied to work out the effect of different treatments on growth of fish and Statistical significance level was assumed as $p<0.05$ Duncan’s multiple range test (DMRT) were performed using SPSS 22.0 software.

Results

The values for all the water quality parameters and nutrient status were within the optimum range throughout the culture period. 100% survival of fish was recorded in all the treatments. Initial and final average weight (g), Length – weight relationship of fishes stocked in different tanks, values of regression co-efficient ‘b’ and logarithmic relationship between length and weight with regression equation are given in Table 2 and Fig. 1. Average final body weight was found to be highest in T6 followed by T5, T4, T3, T2, T1 and control, whereas SGR was found to be highest in T6 followed by T5, T4, T3, T2, T1 and control.

The maximum value of condition factor ‘K’ was recorded in treatment T5 (2.31) followed by T6 (2.15) and T4 (2.09), Control (2.01), T2 (1.96) and T1 (1.92), and T3 (1.86). The values of ‘K’ in T5, T6, and T4 were higher than control, suggesting that fishes, which were in higher concentration of spent wash (i.e. 2.5ml/l and 2.0 ml/l) and in cow dung were much more robust than the fish in control i.e. without fertilizer.

Table 2: Length weight relationship of *Labeo rohita* in different treatments.

Treatments	Initial Average Weight (g)	Final Average Weight (g)	SGR	Logarithm equation Log W= Log a +b Log L	b	Correlation co-efficient r	Coefficient of determination r^2	Condition Factor K
C	10.27 ± 0.05	50.60 ± 0.37	1.29	Log W = Log 3.7892+ 2.5684Log L	2.56	0.9426	0.8885	2.01
T_1	10.22 ± 0.06	52.20 ± 0.33	1.35	Log W = Log 4.0024 +2.6522 Log L	2.65	0.9296	0.8643	1.92
T_2	10.20 ± 0.03	54.17 ± 0.22	1.42	Log W = Log 3.8219+2.6650 Log L	2.66	0.9355	0.8752	1.96
T_3	10.30 ± 0.14	55.77 ± 0.38	1.49	Log W = Log 3.8531+2.7857 Log L	2.78	0.9790	0.9585	1.86
T_4	10.50 ± 0.25	57.48 ± 0.31	1.50	Log W = Log 3.7277+2.7956 Log L	2.79	0.9663	0.9338	2.09
T_5	10.22 ± 0.20	59.86 ± 0.25	1.62	Log W = Log 4.1876+2.8358 Log L	2.83	0.9779	0.9563	2.31
T_6	10.26 ± 0.16	60.20 ± 0.43	1.63	Log W = Log 3.8189+2.9123 Log L	2.91	0.9727	0.9463	2.15

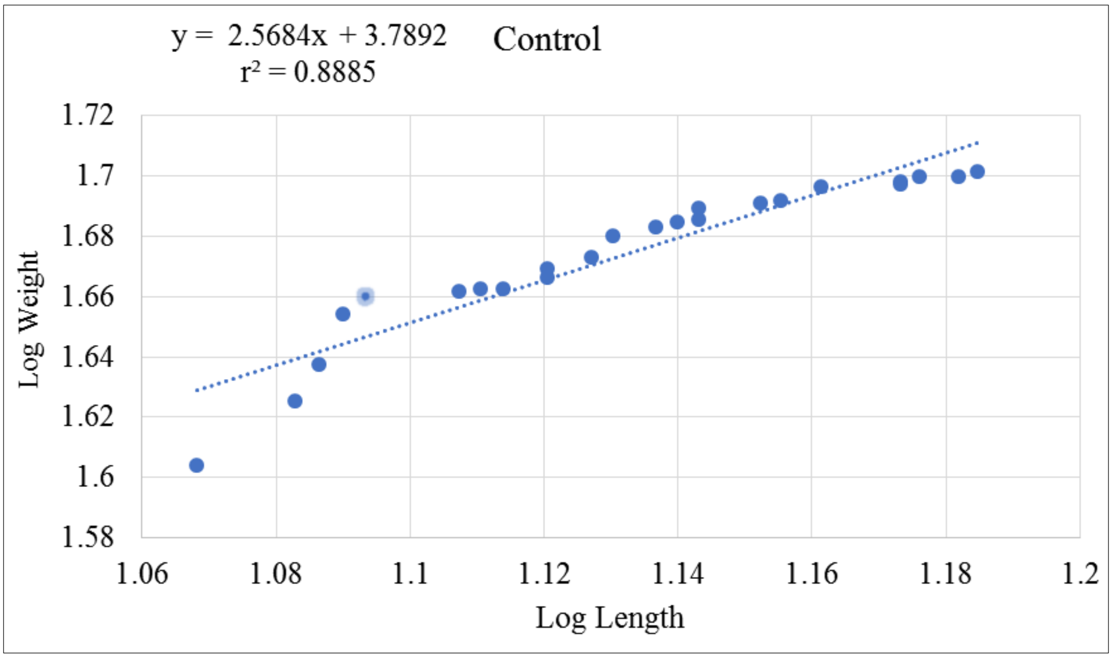


Fig 1 a

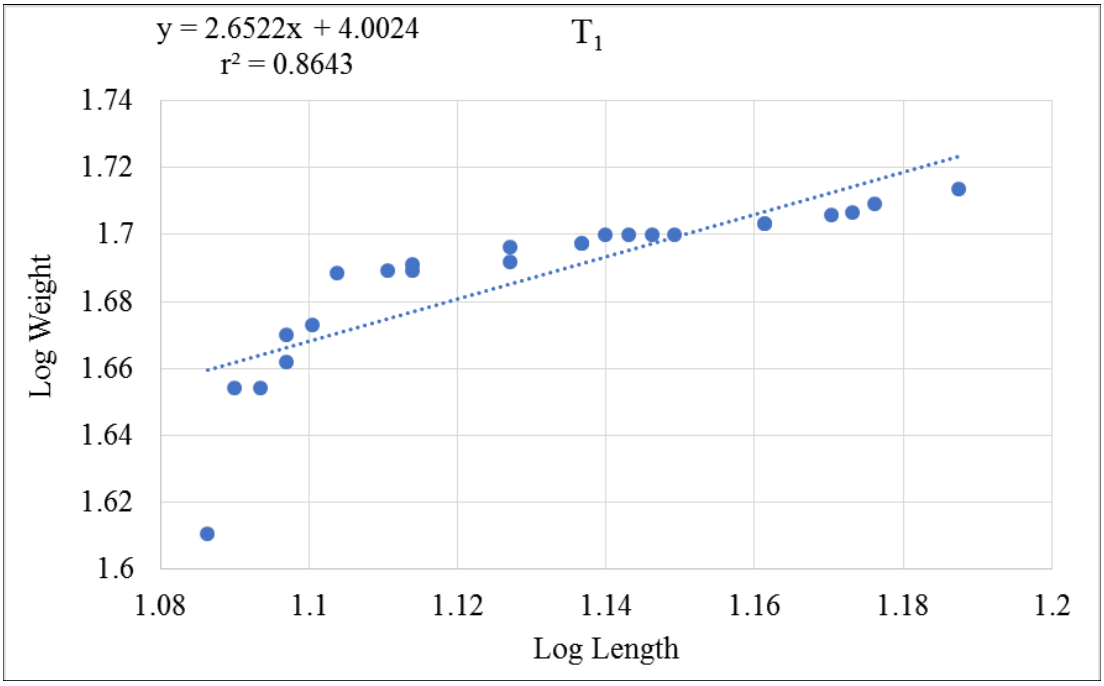
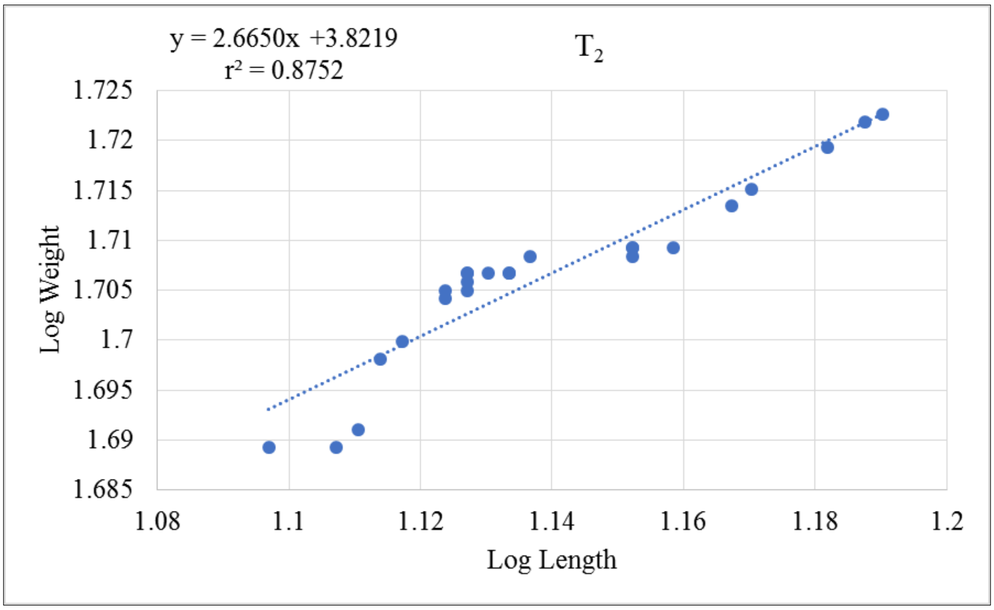


Fig 1 b



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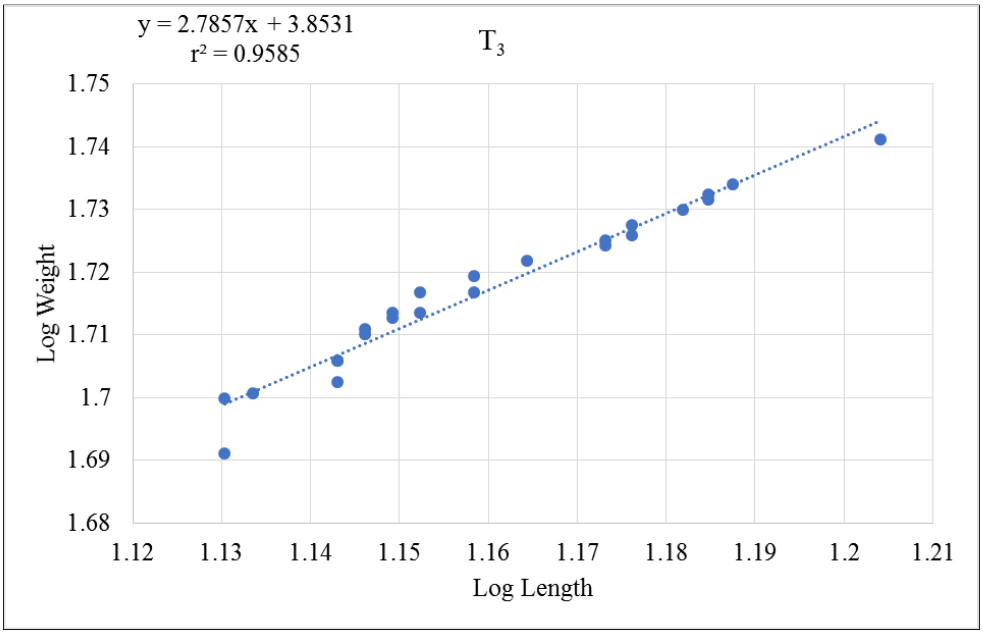

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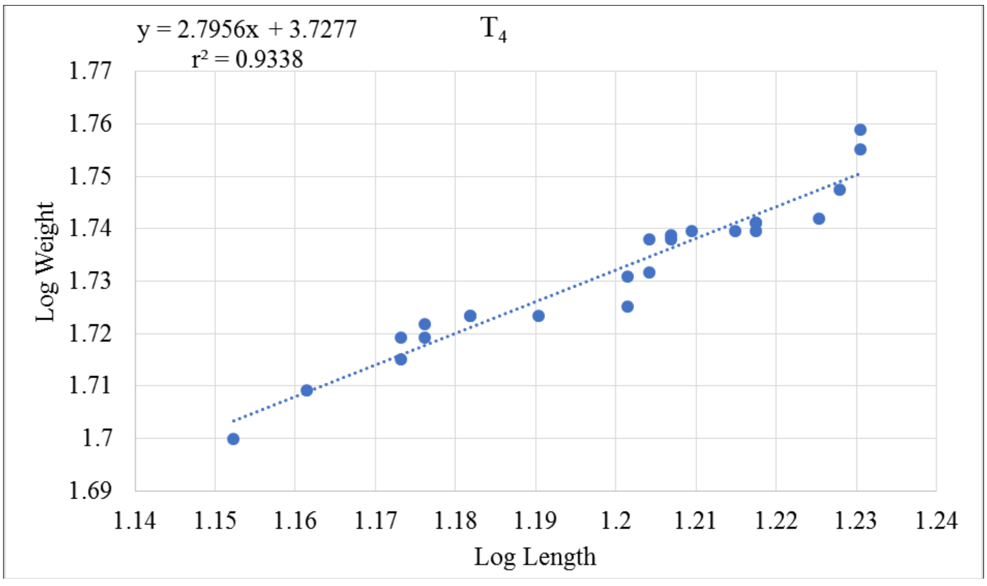

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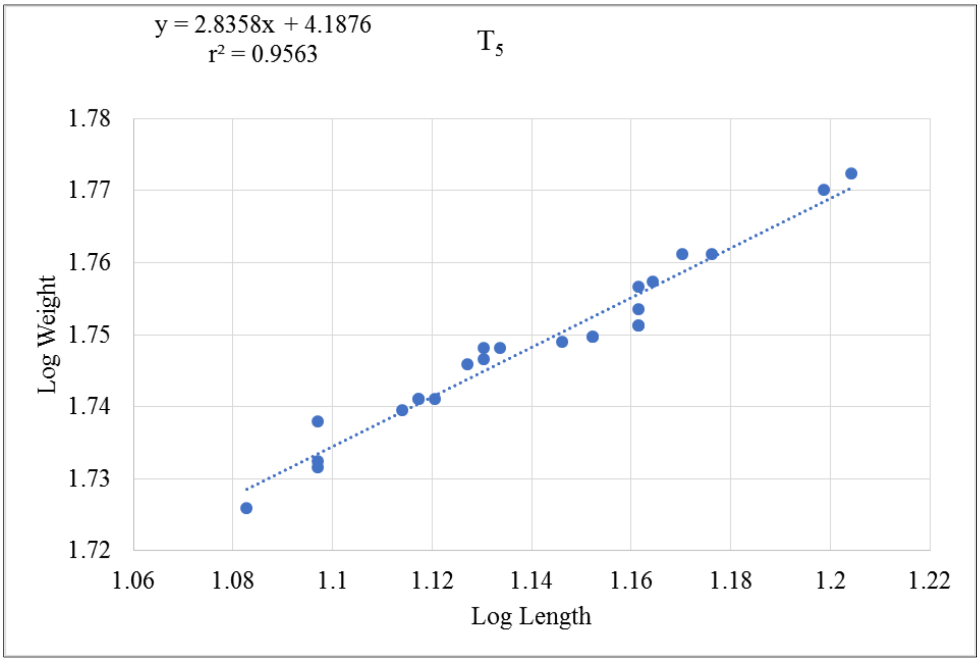

Fig 1 f

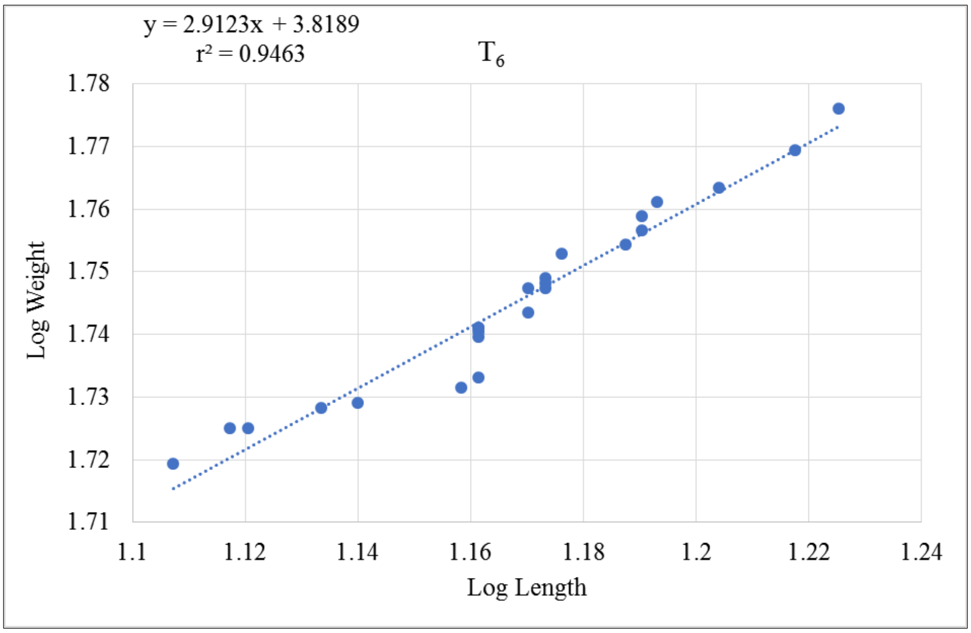

Fig 1 g

Fig 1 a-g: Logarithmic relationship between length and weight with regration equation of *Labeo rohita* in different treatments.

Discussion

Length and weight relationship studies are important to analyse growth, age and other components of fish studies. Similar studies have been carried out by Shukla *et al.* (2016) [17] and Mourad *et al.* (2008) [12]. Growth is said to be positive allometric when the weight of an organism increases more than length (b>3) and negative allometric when length increases more than weight (b<3) (Wooton, 1992) [21]. When total body length regressed with body weight, the slope value gets significantly lower than critical isometric value i.e. 3. In the present study 'b' varied between 2.56 to 2.91 in all the treatments indicating slightly negative allometric growth, due to which species become slender as it increases in length (Pauly, 1984) [14]. The results of present study are in conformity with the views of Le Cren (1951) [11] and Chauhan (1987) [5] that a fish normally does not retain the same shape or body outline throughout their life span and specific gravity of tissue may not remain constant and the actual relationship may depart significantly from Cube Law. Pauly et al. (1997) [15] reported that value of 'b' ranged between 2.5 to 3.5, which suggests that the results of the present study coincide with these observations. Negative allometric growth has also been reported in previous studies in *H. fossilis* (Shukla *et al.*, 2016 and Khan *et al.*, 2012) [17, 8] and *Channa punctatus* (Ali *et al.*, 2002; Haniffa *et al.*, 2006) [3, 7]. Variation in slope may be attributed to sample size variation, life stages and environmental factors (Kleanthids *et al.*, 1999) [9]. Highest slope of *L. rohita* in T5 reflected the faster growth (in term of weight parameters) of fish compared to other treatments. The coefficients of determination (r^2) values in all the diets except T1 were higher than control indicating proper and good fitness of model.

The condition factor (K) of a fish reflects physical and biological characteristics and fluctuations by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren, 1951) [11] along with assessment of fish condition (Lambert and Dutil, 1997) [10] based on weight at a given length (indicating energy reserves in fish). This also indicates the changes in food reserves and therefore an indicator of the general fish condition. Moreover, body condition provides an alternative to the expensive *in vitro* proximate analysis of tissues (Sutton *et al.*, 2000) [19]. Therefore, information on condition factor can be vital to culture system management because they provide the producer with information of the specific condition under which organisms are developing (Araneda *et al.*, 2008) [4].

Conclusion

In the present study, the length weight relationship of *L. rohita* increase with the weight and thereby shows the weight of the fish is a function of length. The relation between length and weight is expressed by hypothetical law $W = aL^b$ and the value of b fish is closely related to 3 as like an ideal fish. This study provides first basic and base line information on LWR of this commercial importance fish in captive condition. This would be beneficial to fish farmers and researchers to adopt various management techniques for sustainable production of this fish species, which may further help in doubling the farmers income.

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