International Research Journal of Environmental Sciences ISSN 2319–1414
Vol. **7(2),** 18-23, February **(2018)** *Int. Res. J. Environmental Sci.*

Condition factor as growth indicator of *Labeo rohita* fingerlings cultured using different diets containing bioflocs and commercial feed pellets

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Available online at: www.isca.in, www.isca.me
Received 27th November 2017, revised 9th February 2018, accepted 20th February 2018

Abstract

The present study is focussed on the growth pattern of Labeo rohita fingerlings cultured under laboratory conditions by determining its length weight relationship (LWR) and condition factor (K). Four treatment units including control were employed with one replicate for culture of Labeo rohita fingerlings and maintained for a period of 90 days. Fingerlings fed on commercial feed alone served as control. Insitu bioflocs were used as feed in Treatment 1, whereas in Treatment 2, fingerlings were fed with exsitu bioflocs cultured in another source and harvested for feeding. In Treatment 3 fingerlings were fed with both commercial feed and exsitu bioflocs in the ratio 1:1. Individual weight and length of fingerlings was measured at the start and end of culture period using ruler and weighing balance respectively. The length-weight relationship and condition factor was estimated based on the length and weight data. Length weight relationship (LWR) was computed by the equation: $W = a L^b$. The value of the regression co-efficient 'b' obtained from the LWR was 3.41, 3.85, 1.59 and 3.68 for Control, Treatment 1, Treatment 2 and Treatment 3 respectively. The value of 'b' clearly depicts that the growth pattern was allometric and not isometric. The condition factor calculated for Labeo rohita were 0.97, 1.04, 1.03 and 1.03 which indicated that fishes were in good condition in Treatment 1, Treatment 2 and Treatment 3 whereas in poor condition in Control, during the study period.

Keywords: Condition factor, *Labeo rohita*, length-weight relationship, isometric.

Introduction

Growth of fish corresponds to growth in both the length and weight. Different fishes show different growth rates depending upon their genetic makeup, food resources available and the environment conditions in which they live and grow[1]. The relative health, strength or well-being index of a fish is depicted as "coefficient of condition" and is also known as condition factor or length-weight factor. Each fish as a matter of fact has a characteristic range of condition factor which is reflected in their body conformation[2]. Variations in the condition coefficient of a fish reflects the state of sexual maturity and degree of nourishment[3]. Condition factor is an indicator of adverse environmental and management conditions and feeding and other environmental factors lead to fluctuations in the condition factor. Therefore condition factor can be used to determine whether the fishes are utilizing their feeding source efficiently[4-6]. Thus determination of condition factor is extensively studied aquaculture studies[7].

Length-weight relationship (LWR) studies of fishes are very significant in fisheries biology because from a given length of fish its corresponding weight can be calculated[8,9]. In addition, it helps to determine condition and growth pattern of fish[10].

Length is a linear measure (cm) and the weight of a fish (g) is approximately equal to its volume (cm^3). Hence, weight of a fish is a function of length. The relationship can be expressed by the hypothetical law $W=aL^3$. The value of exponent may deviate from the value 3, because the fishes show change in the shape or outlook as they grow[11]. The variation from expected weight to the actual weight of individual fish is calculated by length weight relationship.

LWR parameters (a and b) are used in fisheries studies due to following reasons: i. For calculating weight of individual fish from its length, ii. For the estimation of condition indices, iii. to compare life history and morphology of populations belonging to different regions[12].

This present research work was thus carried out to determine length weight relationship of fingerlings of *Labeo rohita* cultured in different treatments and also to determine their general wellbeing by calculating their condition factor.

Materials and methods

The test animal i.e. fingerling stage of *Labeo rohita* collected from nearby fish farm were stocked in four treatment units at a rate 25 fingerlings in each group and fed with different diets which is discussed as under:

Control: Fingerlings were fed with commercial feed pellets at 4% body weight during morning and evening hours.

Treatment 1 (T-1): Insitu bioflocs acted as feed for cultured species.

Treatment 2 (T-2): Exsitu bioflocs (grown outside the fish culture treatment) were used as feed. Animals were kept in biofloc suspension added twice daily and no additional commercial feed was provided[13].

Treatment 3 (T-3): A feed mix of commercial feed pellets and biofloc was given to the fingerlings in the ratio 1:1. Ex-situ grown bioflocs were used.

Length-Weight measurement: At the first day and 90th day of culture period, individual length and weight of fingerlings was taken in triplicates. Length was measured from mouth tip to the caudal fin using meter rule calibrated in centimetres. Weight was measured with the help of weighing balance. Length – weight relationship was expressed as:

$W = aL^{b}$[14]

Where: W = weight of fish in grams, L = total length of fish in centimetres, a = the rate of change of weight with length (= the intercept of the regression line on the Y axis), b = slope of the regression line (also known as the Allometric coefficient).

The regression equation is obtained by using log.

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

Where: a = Constant b = regression co-efficient

The values of "a" and "b" were obtained from a linear regression of the length and weight of fish. The correlation coefficient (r) or the degree of association between the length and weight was calculated from the linear regression analysis:

$r = R^2$

Condition factor: The condition factor (K) was established using length and weight data following the equation suggested by Le Cren[15]: $K = 100\ w/L^3$

Where: W = weight of fish, L = total length of fish, 100 = factor to bring the value near to unity.

Water quality analysis: During the experimental period, various physiochemical parameters of water were analysed on weekly basis viz. pH, water temperature, dissolved oxygen (DO), free carbon dioxide (FCO_2) and ammonia using standard methods[16].

Results and discussion

The mean length and weight of fingerlings at the start and end of experiment in all treatment units has been presented in Table-1. The initial mean length for *Labeo rohita* was 8.97 ± 0.11 cm, 8.88±009cm, 8.48±111cm and 8.56±012cm while the mean weight was 9.55±111g, 9.25±098g, 8.84±089g and 8.97±023g in Control, Treatment 1, Treatment 2 and Treatment 3 respectively.

Length weight relationship (LWR) and Condition factor (K): The Length-weight relationship of different treatment groups, regression parameters, correlation coefficients (r) and corresponding equation was worked out and the details are presented in Table-2. The value of the regression coefficient 'b' obtained from the LWR was 3.41, 3.85, 1.59 and 3.68 for fish fed on different diets in Control, Treatment 1, Treatment 2 and Treatment 3 respectively. Carlander[7]; Beverton and Holt[18] stated that weight of the fish increased logarithmically with an increase in length, showing value between 2.5 and 3.5 but usually close to 3.0, also referred as 'cube law'. In the present experiment, the 'b' value have been found to be above 3 for control, Treatment 1 and Treatment 3 whereas below 3 for Treatment 2. This clearly indicate that increase in weight is much more than the cube law in aforesaid three treatments whereas in Treatment 2 weight increased less as compared to length and the fishes were lean in outlook.

Moreover, the b value is calculated to predict the growth pattern of the fish whether it sows allometric or isometric growth. If b value of 3.0 show isometric growth, and this value is obtained only when the density and form of the fish are constant. If it is allometric, the fish grows with weight increasing at slower (b< 3.0) as in case of T-3 or faster (>3.0) as in case of control, Treatment 1 and Treatment 3 relative to increase in length. The fishes continue to grow throughout life. Faster growth reflects abundant food supply and other favourable conditions, whereas slow growth indicates non-availability of food[19]. Moreover, several other factors could also be the cause of variation in b values such as water quality and food availability[20]; sample size and length range[21].

Table-1: Mean Length and Weight characteristics of fingerlings cultured during experimental period.

Treatment	Control Length/ Weight (cm/g)	T-1 Length/ Weight (cm/g)	T-2 Length/ weight (cm/g)	T-3 Length/ weight (cm/g)
Initial	8.97/9.55	8.88/9.25	8.48/8.84	8.56/8.97
Final	11.45/14.58	14.83/29	10.23/11.06	12.23/19

Table-2: Descriptive statistics of length weight relationship of different groups of fingerlings of *Labeo rohita.*

Treatment	Length range (cm)	Relationship parameters		Correlation coefficient R^2	Condition factor K
		a	b		
Control	10.95-11.90	-24.45	3.41	0.99	0.97
T-1	14.00-15.50	-28.21	3.85	0.99	1.04
T-2	10.05-10.50	-5.28	1.59	1.00	1.03
T-3	11.50-13	-26.06	3.68	0.99	1.03

The following regression equations for Control, Treatment 1, Treatment 2 and Treatment 3 respectively were obtained:

Control = Log W = -24.45 + 3.41 log L.
The correlation co-efficient (r) value is 1.00.

Treatment 1 = Log W = -28.21 + 3.85 log L.
The correlation co-efficient (r) value is 1.00.

Treatment 2 = Log W = -5.28 + 1.59 log L.
The correlation co-efficient (r) value is 0.99.

Treatment 3 = Log W = -26.06 + 3.68 log L.
The correlation co-efficient (r) value is 1.00.

The correlation coefficient was found to be 1.00 in case of control, Treatment1 and Treatment 3 and 0.99 in Treatment 2 that indicate that there is high positive correlation between length and weight of fingerlings in these treatments.

Length–weight relationship of Indian major carp has been discussed by Chakrabarty and Singh[22], Natarajan and Jhingran[23], Kamal[24] from different localities of India. Qasim[25] and Bal and Rao[26] reported that a and b differ not only among different species but also within the same species depending on sex, stage of maturity and food habits.

The results further indicated that insitu biofloc treatment i.e. Treatment 1 is suitable for efficient growth in length and weight of fingerlings because insitu bioflocs are recycled continuously within the culture system and are available all the time for feeding. In exsitu biofloc treatment i.e. Treatment 2 the availability of bioflocs was not continuous because the bioflocs remain in suspension for some time and then settled out becoming unavailable for feeding. Biofloc+artificial feed combination i.e. Treatment 3 also showed efficient growth in length and weight which may be due to the consumption of bioflocs by the fingerlings and additional use of artificial feed so that the fingerlings did not starved when the externally added biofloc settled out. Artificial diet i.e. control also moderate growth possibly due to preferable spirulina pellets that were procured from market.

Condition factor (K): The mean condition factor, K±SD values are given in Table-2. The condition factor computed for *Labeo rohita* was 0.97, 1.04, 1.03 and 1.03 for fingerlings fed on artificial diet, insitu biofloc, exsitu biofloc and combined artificial diet+exsitu biofloc respectively. In the diets containing bioflocs, i.e Treatment 1, Treatment 2 and Treatment 3 the condition factor was above 1, which demonstrated their good health condition during the experiment and the absence of any stress factor. The minimum K (0.97) was noticed for control using artificial diet and maximum for Treatment 1 (1.04) using insitu bioflocs.

Determination of Condition coefficient is a standard technique in fisheries and is used as an indicator of the variability attributed to growth coefficient (b)[27]. Whetherley[5] reported that variation in condition factor with length is observed even among the members of one population, sampled on the same day.

Ujjania *et al*[28] studied the condition factor of *Labeo rohita* from three water bodies of Rajasthan and reported that condition factor and relative condition factor were 1.0 or >1.0 which shows good condition of fish in these water bodies. The condition factor is an accepted criterion for the well being of the fish. Crab *et al.*[29] while working on tilapia in extreme winters observed a uniform condition factor of 2.2 which indicated that the fish were in good condition with minimal stress symptoms.

Water quality analysis: The water quality is a crucial parameter that has a well marked influence on the growth and survival of fingerlings. Any change in the physico-chemical parameters may affect the growth, development and maturity of fish[30].

During the culture period, mean±SD water temperature recorded was 20.6±0.098^{0}C, 20.8±0.023^{0}C, 21.0±0.061^{0}C and 21.0±0.046^{0}C in Control, Treatment 1, Treatment 2 and Treatment 3 respectively (Table-3). Jhingran in 1978[31] reported that carps thrive well between 18.3^{0}C and 37.8^{0}C thus the temperature in all the four treatment units were found to be suitable for survival of *Labeo rohita* fingerlings. pH showed slight variations with mean±SD values as 7.8±0.037, 7.4±0.052 and 7.5±0.021 and 7.2±0.009 in Control, Treatment 1, Treatment 2 and Treatment 3 respectively (Table-3).

Santhosh and Singh[32] recommended the suitable pH range for fish culture between 6.7 and 9.5 and ideal pH level is between 7.5 and 8.5 and above and below this is stressful to the fishes. In treatment 1, operated with insitu biofloc, the addition of molasses led to the decline in pH that reached upto 4.9 and maintained to 7.4 by the addition of sodium bicarbonate. Azim *et al.*[33] reported that biofloc system lose buffering ability and therefore require regular addition of $NaHCO_3$. Mean±SD values of DO were 5.6±0.158mg/l in control, 5.4±0.130mg/l in treatment 1, 5.4±0.085mg/l in Treatment 2 and 5.4±0.012mg/l in Treatment 3 (Table-3). DO was recorded to be maximum in control unit i.e control with comparatively lower values in treatment units 1, 2 and 3. This may be due to its utilisation by multiplying bacteria which was lacking in control however it was maintained above 5 mg/l by continuous aeration.

Free carbon dioxide concentration (mean±SD) was found to be 12.0mg/l, 14.0mg/l and 12.0mg/l and 12.0mg/l in Control, Treatment 1, Treatment 2 and Treatment 3 respectively (Table-3). At the start of the experiment, its concentration was low but during the culture period it showed increasing trend due to its release during respiration by fingerlings of *Labeo rohita* and bacterial respiration. It was also observed that F CO_2 concentration was slightly higher in Treatment which might be due to the multiplication of bacteria and continuous utilisation of dissolved oxygen.

Average ammonia level was recorded to be 0.68±0.008mg/l, 0.43±0.012mg/l, 0.50±0.098mg/l and 0.43±0.081mg/l in Control, Treatment 1, Treatment 2 and Treatment 3 respectively (Table-3). Insitu biofloc culture system, Treatment 1 showed lowest ammonia level because of the conversion of ammonia into bacterial protein by heterotrophic bacteria. Exsitu biofloc system i.e. Treatment 2 showed slightly higher concentration of ammonia than insitu culture system. This may be attributed to the external addition of biofloc suspension that converts some of the ammonia into bacterial biomass.

Table-3: Mean±SD various water quality parameters recorded during the experiment.

Water quality parameters	Control	T-1	T-2	T-3
Temp. (^oC)	20.6± 0.098	20.8± 0.023	21.0± 0.061	21.0± 0.046
pH	7.8± 0.037	7.4± 0.052	7.5± 0.021	7.2± 0.009
DO (m/l)	5.6± 0.105	5.4± 0.130	5.4± 0.085	5.4± 0.012
Free CO_2 (mg/l)	12.0± 0.011	14.0± 0.010	12.0± 0.009	12.0± 0.032
Ammonia (mg/l)	0.68± 0.008	0.43± 0.012	0.50± 0.098	0.54± .0.081

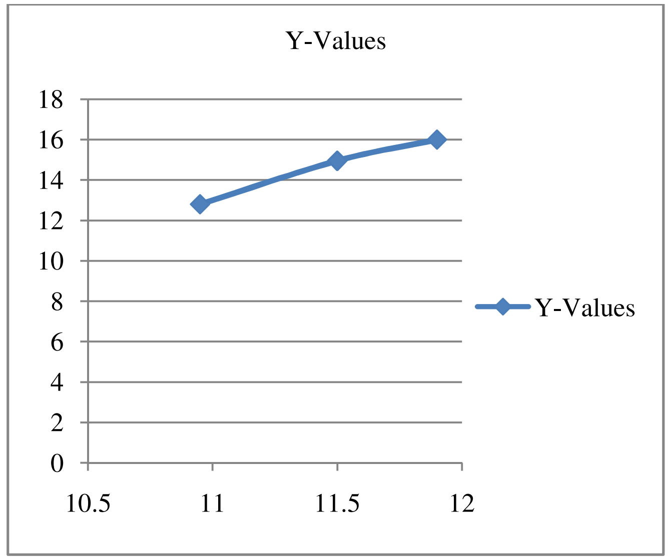

Figure-1: Length Weight relationship of fingerlings in control.

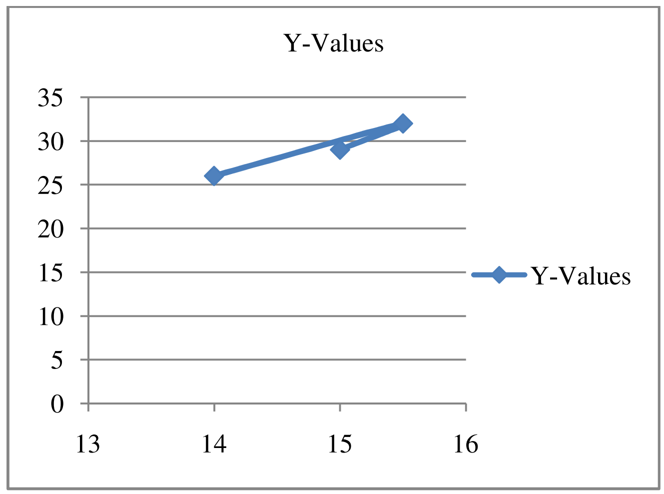

Figure-2: Length Weight relationship of fingerlings in T-1.

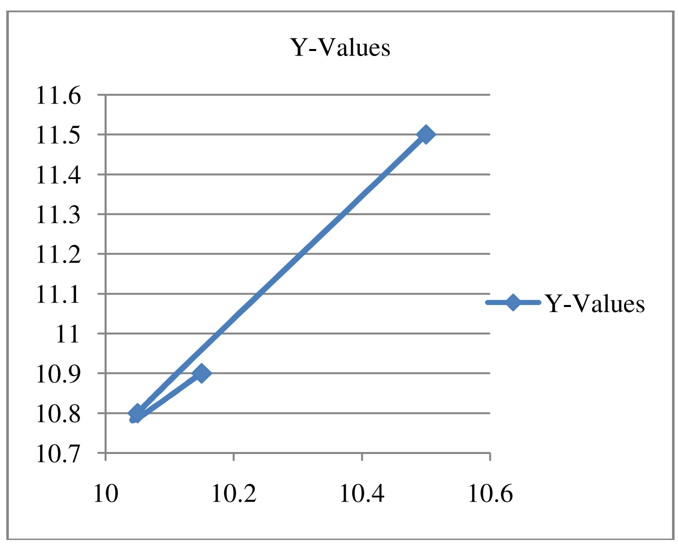

Figure-3: Length Weight relationship of fingerlings in T-2.

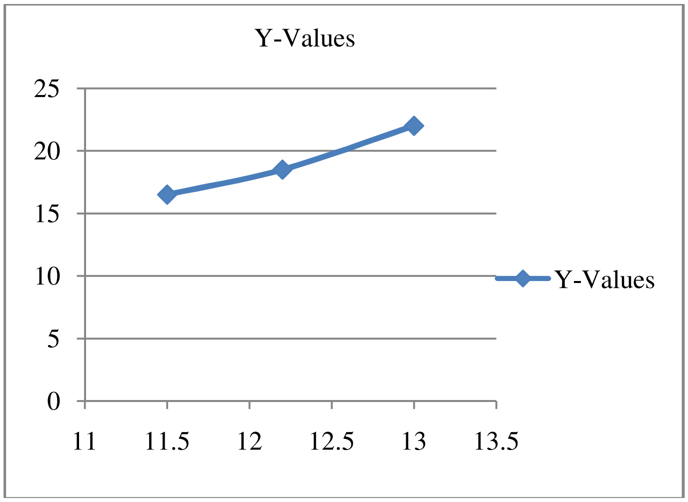

Figure-4: Length Weight relationship of fingerlings in T-3.

Conclusion

From the present study, the following conclusions are made: Insitu bioflocs as feed are highly efficient for growth with respect to length weight relationship which can be authenticated by condition factor above 1, value of b above 3, highest increment in length and weight and water quality maintenance without exchange throughout the culture period.

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