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Length-Weight Relationship and Condition Factor of *Labeo rohita* (Hamilton, 1822) in Aquaponics System

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present experiment was conducted in circular FRP tanks kept indoor under polycarbonate house to provides information on the length-weight relationship and condition factors of *Labeo rohita* in aquaponics system. Aquaponics, an integrated system of aquaculture and hydroponics,

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has gained significant attention due to its sustainable and efficient nature. Understanding the growth dynamics and condition of fish within such systems is crucial for optimizing production and maintaining fish health. The length weight relationship were estimated by linear regression equation. The species exhibits positive allometric growth (b>3) with the values of condition factor (K) being greater than one, indicating the well-being of the species in its natural habitat. The water quality parameters were within the acceptable range for fish production. A fine mesh net is used to scoop fishes. The fish total length was measured from the anterior tip of the snout to the distal end of the caudal fin, and its weight was assessed using a precision single-pan electronic balance. Result shown that, the length-weight relationship of 900 experimental fish in aquaponics system with different stocking density shows that the treatment T_2 performed better than T_1 and T_3. *L. rohita* juveniles reared in experimental tanks exhibited positive allometric growth and in good condition of health. This growth pattern favours fish farming as it enhances its profitability. The values of 'K' ranged from 0.97-1.00 which depicted good condition of fish in these water bodies. These observed parameters were useful to evaluate the well-being of *L. rohita* population in the aquaponics system and provided useful information on fish biology for scientific management of fisheries.

Keywords: Aquaponics; condition factor; length-weight relationship; Labeo rohita.

1. INTRODUCTION

"Length-weight relationship (LWR) provides basic information on fish biology and is useful to determine the weight of an individual fish of known length" (Beyer, 1987). "This relationship is an important biometric tool that has been used widely for fishery management purposes" (Gupta & Banerjee, 2015) and "estimates condition factor of the fish species and fish biomass through the length frequency" (Froese & Pauly, 1998). "LWR provides information on several parameters *viz.* growth pattern, general health, habitat conditions, life history, fish fatness and morphological characteristics of the fish" (Schneider *et al*. 2000; Froese, 2006). "This relationship gives an idea about the growth condition of fish and helps in determining whether the somatic growth is isometric or allometric" (Ricker, 1975) and "important in fishes and fish biology because they allow the estimation of average weight of fish of a given length group by establishing a mathematical relation between them" (Haimovici & Velasco, 2000; Mercy *et al.,* 2002; Sarkar *et al.,* 2008; Mir *et al.,* 2012). "Length and weight of Indian Major Carps in relation to growth parameters have been studied by many workers" (Johal & Kingra, 1992; Ahmed & Saha, 1996; Jain, 2000, Saxena & Saxena, 2009; Bhat, 2011). "Besides LWR, condition factor (K) indicates the suitability of water body for growth of fish" (LeCren, 1951). "The condition factor is an index of species average size while relative condition factor is the ratio between observed weight and calculated weight of fish. The values of these factors depend on physiological features of fish such as maturity, spawning, environmental factors and food availability in a water body. Condition factor for carps have been estimated by several researchers from different types of water bodies in different regions and environments of the country" (Choudhari *et al.,* 1982; Johal & Tandon, 1983; Rajbanshi *et al.,* 1984; Zafar & Mustafa, 1992). "Condition factor decreased with increase in length and is also influenced by the reproductive cycle of fish" (Welcome, 1979). "It is important to assess the relative well-being of fish population" (Bolger & Connolly, 1989). *Labeo rohita* (Hamilton, 1822) "locally known as 'rohu' is a column feeder and herbivore having fast growth and well distributed throughout India. Both of them are extensively cultured in tanks, ponds, beels and reservoirs and have very good consumer demands in local markets" (Sarkar *et al.,* 2017). In North India, most of the fish farmers stock carp fishes in their ponds and these fishes are also suitable for aquaponics system. The Rohu (*Labeo rohita*) is most common preferred fish by consumer, it is therefore *L. rohita* has been selected for present investigation.

"Fish farming has grown strongly as an effective way of generating food and income from dwindling land space, as fish supplies from open water and lagoons continue to fall and human population increases" (Adebayo & Adesoji, 2008). Fish production system has seen several innovative approaches in recent years. These approaches aim to improve the sustainability, efficiency and environmental impact of fish farming while meeting the growing demand for food (Subasinghe *et al.,* 2009). innovative approaches are continuously evolving, driven by advancements in technology, research and sustainable farming practices (Føre *et al.,* 2018).

Among them fish aquaponics system is better than others as it not only produces fishes but also help in increasing farmer's income through the production of other agricultural products *viz.* vegetables, fruits, flowers etc. Aquaponics, an integrated system of aquaculture and hydroponics, has gained significant attention due to its sustainable and efficient nature. "It is seen to be one of the key food production technologies which 'could change our lives'" (Van *et al.,* 2015), "in terms of sustainable and efficient food production. It can be more productive and economically feasible in certain situations, especially where land and water are limited" (Somerville *et al.,* 2014).

The present investigation focuses on length-weight relationship and condition factor of the commercially important Indian Major Carp, *L. rohita* in aquaponic system. This study provide information may be helpful for management, conservation and aquaculture of this species.

2. MATERIALS AND METHODS

The study was carried out in aquaponics system were examined during 120 days of period of investigation. Sampling of growth parameters of fish *viz.* length and weight of the fingerlings were recorded as start and every fortnightly following AOAC (2017). A fine mesh net is used to scoop individual fish or small groups. It's gentle and minimizes stress. Analysis of growth parameters was completed at the experimental site and in the laboratory of Department of Aquatic Environment Management. Total length of the fish was measured from the snout to the tip of the tail and weighed in single pan electronic balance. The standard length and weight relationship were taken in *L. rohita* has been determined using the fish size.

The parameters 'a' and 'b' were estimated by linear regression equation given by Le Cren (1951) and Jones (2002), this equation is also referred as the length-weight key (Biswas, 1993):

$$W = a L^b$$

i.e., log W = log a + b log L.

Where, 'W' and 'L' are the variables, 'a' is coefficient related to body form or intercept and '*b*' is exponent or slope.

The correlation coefficient (r) was calculated following standard statistical procedure of Snedecor and Cochran (1967). Condition factor (K) were determined for different length groups using length and weight data following the equation given by LeCren (1951):

$$K= W*100/ L^3$$

where W is the total body weight of fish and L is the total length.

3. RESULTS AND DISCUSSION

The observed length-weight relationship and condition factor provide valuable insights for optimizing aquaponic production practices and ensuring the well-being of fish within these systems. LWR parameters of fish are reported to be affected by several factors such as season, habitat, maturity, feeding intensity, variations in environmental conditions, sampling methods and the length range of samples collected (Bagenal & Tesch, 1978; Froese, 2006). The relationship between standard length and weight is represented by the equation $Y = a X^b$ or $W = a L^b$ where 'W' is weight, 'L' is length. Besides these variables, 'a' and '*b*' give intercept and slope, respectively.

Table 1. Length- weight relationship and condition factor of *Labeo rohita* in aquaponics system

Treatment	Samples	*b*	K
T1	200	2.415	1.00
T2	300	3.375	0.97
T3	400	2.828	1.00

b= length- weight relationship, K= Condition factor

In length-weight relationship, the *b* value of experimental trails was 2.415 (T_1), 3.375 (T_2), 2.828 (T_3). The b value varies from 2.415-3.375 in this system (Table 1). The value of regression coefficient '*b*' from pooled data showed an isometric growth of the fish in present study as the values were around '3'. The highest value (3.375) of length-weight relationship was recorded in T_2 and lowest value (2.415) in T_1. The expected range of $2.5 < b < 3.5$ is confirmed in most fishes (Froese, 2006). The condition factor (K) gives information on the physiological condition of fish in relation to its welfare. The findings of current study, the condition factor (K) of *L. rohita* in aquaponics system was observed to indicate values >1.0 which could be considered valid evidence of good condition of fish. This value varied from 0.97-1.00 from

different stocking density of fish. The findings of length-weight relationship in the present investigation were similar to the findings of Sharma and Ali (2022), who found a '*b*' value of 3.294 in *Pethia punctata*. Similar findings were given by Naeem and Salam (2005) who reported 3.32 value of '*b*' for bighead carp *(Aristichthys nobilis)*. According to Davies *et al.* (2013) "the ¨*b*¨ values of this study revealed that the *Clarius gariepinus* juveniles reared in concrete tanks exhibited positive allometric growth and the overall mean condition factor ranged between 1.06 and 1.15". Sarkar *et al.* (2017) reported "the '*b*' value of fish was found 2.904 in Labeo *bata* and 2.890 in rohu in the present study which did not differ significantly ($p<0.05$) from cube (3) and thus fish exhibited isometric growth". Similar findings of Srithongthum *et al.* (2020) who stated that "the *b* value of the females was 3.10 (> 3.0), indicating that they have attained positive allometric growth thus the result showed that these *b* values were not significantly different, indicating that the fish has achieved ideal growth". Mandal *et al.* (2018) reported that "the LWR of males, females and pooled population was noticed. The regression coefficient (*b*) ranged from 2.07-3.68 for pooled, 0.75-3.03 for males and 1.78-2.97 for females". Similar findings of Thierry *et al.* (2021) stated that "the parameters of the length-weight relationship showed a negative allometric growth regression of 2.7135 for albacore tuna (*Thunnus alalunga*), 2.3275 for yellowfin tuna (*Thunnus albacares*) and 2.4047 for bigeye tuna (*Thunnus obesus*). Nevertheless, the albacore and yellowfin tuna females were characterized by positive allometry (b>3). Length-weight relations were negatively allometric ($W = 0{,}1184L^{2{,}3719}$) of White pomfret (*Pampus argenteus*)" (Hikmawansyah *et al.,* 2019). According to Mabika *et al.* (2024), "the value of the exponent *b* in the LWR for *Hydrocynus vittatus* was 2.984, indicating negative allometry (*b*<3) and *Oreochromis niloticus* was 3.04 (*b*>3) implying positive allometry and the condition factor for both fish species were greater than 1.60 implying good physiological conditions for both fish species. The slope (*b*) in length-weight relationship equation was 2.40, suggesting a negative allometric growth pattern and the mean value of condition factor was 1.13, which suggested a good condition of the target fish species" (Ankita and Khanb, 2022). Similar findings have been reported by Ujjania *et al.* (2013), "the condition factor were 1.0 or >1.0 which shows good condition of fish in these water bodies". Perry *et al.* (1996) reported that "fishes with a low condition index are presumably believed to have experienced adverse physical environment or insufficient nutrition". According to Asamamaw *et al.* (2019), "the length and weight relationships of *Oreochromis niloticus* was found to be highly correlated (r = 0.964) and significant at the 0.01 level. All the K values were found to be greater than 1, mathematically indicating a healthy status and general well-being of *Oreochromis niloticus* in Koka Reservoir". Similar findings of Jisr *et al.* (2018) reported that "the condition factor (K_n) fluctuated between 0.99 and 1.00, indicating a state of well-being for these fish species".

4. CONCLUSION

The statistical analysis of length-weight relationship of experimental fish in aquaponics system with different stocking density shows that the treatment T_2 performed better than T_1 and T_3. From the present study it is evident that *L. rohita* in aquaponics system enjoyed good condition for their survival and growth, which is isometric in the fish collected from these water bodies as also exhibited by the values of 'b' being ideal (b = 3) together with congenial values of 'K' observed. Throughout the study, it can be concluded that an aquaponic is a bio-integrated, eco-friendly and sustainable system.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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