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Effect of Feed Restriction on Growth Compensation and Muscle Composition in Fingerlings of *Labeo bata* (Hamilton, 1822)

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Abstract

Study reports the impact of feed restriction on growth of fingerlings of *Labeo bata* during experimental period of nine weeks. The fish were subjected to three different treatments (R_1, R_2 and $R_{3)}$, where they were fed at 2% body weight every day for of 1 week, 2 weeks and 3 weeks respectively and subsequently fed 5% of body weight as in control. There was significant difference in weight gain (92.31% in R_1, 82.52% in R_2 and 64.53% in R_3 considering 100% in control) of fish in different treatments ($p<0.01$). The weight gain and specific growth rate in fish of R_1 and R_2 groups did not exhibit significant difference ($p<0.05$) compared to the control. Proximate composition of nutrients in muscle of fish of treatments R_1 and R_2 did not exhibit significant difference compared to control. Feed consumption in treatment R_1 and R_2 was statistically lower in comparison to control indicating one and two weeks of feed restriction can reduce feed consumption as substantially without hampering the growth in fingerlings of *Labeo bata*.

Keywords: Growth compensation, feed restriction, *Labeo bata*

Introduction

Compensatory growth (CG) is a phase of accelerated growth where normal conditions are restored after a period of growth restriction by either lack of food or unfavourable environment (Ali et al., 2003). Compensatory growth is influenced by several factors such as nature of feed restriction, feed composition, age, sex and stage of sexual maturity (Yu et al., 1990). In-appropriate feeding practices in aquaculture may lead to over feeding, higher production cost and pollution of aquatic environment. However insufficient feeding can cause poor growth and fish mortalities leading to losses in the aquaculture. Feeding schedule involving starvation, re-feeding cycles could be a promising feed management option in aquaculture (Azodi et al. 2016). An important approach to reduce feed costs in aquaculture is to develop proper feed management and husbandry strategies availing opportunities of feed restriction and compensatory growth. *Labeo bata* (Hamilton, 1822) is considered as an important candidate species in aqua-farming in eastern India because of its good consumer demand and is being cultured along with other carps in composite type of aqua-farming. An attempt was made to study impact of feed restriction on growth and flesh characteristics of the *L. bata.*

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Materials and Methods

The fingerlings of *L. bata* were collected from local fish seed farm. They were kept in two 500 l rectangular tanks and fed a mixture of live *Tubifex* species and formulated feed for about two weeks prior to the experiment trial. Before on set of experiment, all the fishes were sorted out by size and are starved for one day. Ten numbers of uniform sized fingerlings (average weight of 3.89 g) were kept in each aquaria. Three treatments (R_1, R_2 and R3) with one control (C) and each treatment were tried in triplicate. The experiment was conducted for a period of nine weeks in 12 glass aquarium of size 60 × 30 × 30 cm^3 each. The fishes were fed at 2% body weight every day for the period 1 week, 2 weeks and 3 weeks respectively. The pellet feed was

prepared in the laboratory and used to feed the fish in different aquaria during the period of investigation. The experimental feed was prepared by using 40% fish meal, 30% groundnut oil cake, 17% rice bran, 10% wheat flour, 2% soyabean cake and 1% vitamin mineral mixture. The proximate composition of feed was 35.10% crude protein, 7.51% crude fat, 11.54% crude fibre, 9.84% ash and 28.56% NFE. Subsequently, they were fed at the rate of 5% body weight till the end of experiment. Fishes were fed daily at the rate of 5% body weight in control. Aeration was provided in each aquarium 5 to 7 am. Fishes were fed once at 8 am in a petri dish placed at one corner of each aquarium and excess feed was removed by siphoning after 3 h of feeding.

Proximate composition of feed and fish muscle such as moisture, crude protein, crude fat, crude fibre, total ash were estimated following methods of AOAC (1995). Nitrogen free extract (NFE) was estimated as per Hastings (1979). Fish muscle was collected by taking the lateral body part of fish by avoiding bony parts from a sample of 15 fish per treatment during termination of the experiment. Water quality parameters such as temperature, dissolved oxygen, pH and alkalinity contents of each aquarium were monitored at weekly intervals following standard methods (APHA, 1995). Average weight of fish of each aquarium was estimated by sampling at weekly intervals to record the growth. Specific Growth Rate (SGR) was calculated by using the following formula:

$$\text{Specific Growth Rate} = (\ln W_2 - \ln W_1)/ (t_2 - t_1) \times 100$$

Where, W_1= Weight of fish at time $t_1$and W_2= Weight of fish at time t_2

Differences between treatments were tested for significance using analysis of variance (ANOVA) technique. Mean values of nutrients in fish muscle was tested for significance using t-test.

Results and Discussions

The water quality parameters such as temperature (16.33 to 23.50°C), dissolved oxygen (4.30 to 6.91 mg l^{-1}), pH (7.04 to 7.41) and total alkalinity (147.16 to 163.44 mg l^{-1}) of water were found in suitable range.

The mean weekly increase in average weight and weight gain of *Labeo bata* fingerlings during the experimental period is presented in Fig. 1 and 2 respectively. The specific growth rate in weight during every week is depicted in Fig. 3. The weight gain of fish in the treatment R_1 was relatively more during 2nd, 3rd and 4th weeks and that of R_2 treatment during 3rd to 7th weeks. There was significance difference ($F=5.146$, $p<0.05$) in weight gain of the fish which can be attributed to feed consumption and hyperphagia. It was not significant in treatments R_1 and R_2 compared to control. However, the weight gain of fish in treatment R_3 was significantly low compared to control ($p<0.05$) as well as treatments R_1 and R_2 which might be due to less feed consumption and more duration of feed restriction. The comparatively weight gain was 92.31% in R_1, 82.52%, in R_2 and 64.53% in R_3 considering 100% in control of fish in different treatments ($p<0.01$). Azodi et al. (2016) reported fingerlings of *Lates calcarifer* could compensate growth after 4 days starvation and 8 days re-feeding as well as 8 days starvation and 32 days re-feeding in a cycle. According to Bavcevic et al. (2010) in gilthead sea bream (*Sparus aurata*), compensatory growth in weight was achieved for all the treated groups of fish. Complete growth compensation with restricted feeding was also observed by other researchers in various fish like *Labeo rohita* (Yengkokpam et al., 2013), *Cirrhinus mrigala* (Singh et al., 2005), *Catla catla, Labeo rohita* and *Cirrhinus mrigala* (Mohanta et al., 2016), *Clarias batrachus* (Durairaja & Jawahar, 2014).

Qian et al. (2000) reported that Gibel carp, *Carassius auratus gibelio* (Bloch) are able to show complete growth compensation following 1 and 2 weeks of food deprivation. Wang et al. (2000) reported that in tilapia, *Oreochromis mossambicus* showed compensatory growth response during re-feeding following a period of feed deprivation and observed that hyperphagia was responsible for increased growth rate. Hyperphagia is the main mechanism involved in the compensatory growth response, although increased food conversion efficiencies or behavioural

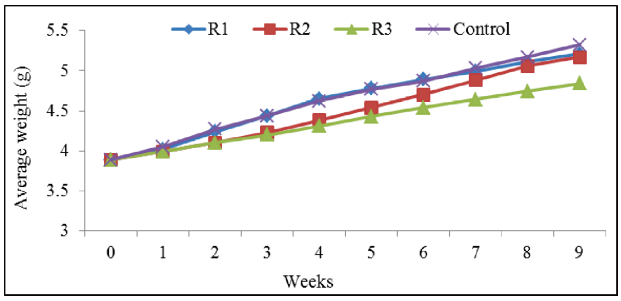

Fig. 1. Average weight of *Labeo bata* under feed restriction

adjustments might play a role (Ali et al., 2003). Pegu & Das (2013) reported growth compensation in *Oreochromis niloticus* after one week of restricted feeding.

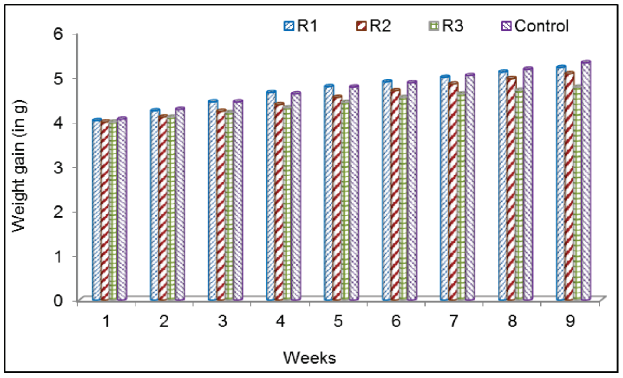

Fig. 2. Average weight gain of *Labeo bata* under feed restriction during 9 weeks of experiment

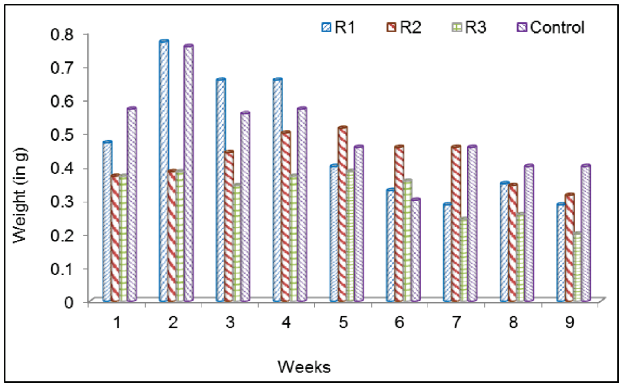

Fig. 3. Specific growth rate of *Labeo bata* under feed restriction

There was significant difference ($F=2.588$, $p<0.05$) in specific growth rate in weight in fingerlings of *L. bata* in different treatments during the period of investigation. The growth of fish was numerically less in R_1 and R_2 but statistically not significant from the control. It indicated that such fish could compensate the growth after feed restriction. The present findings bear similarity with earlier works of Sardar et al. (2008) where fingerlings of *Labeo rohita* exhibited numerically higher and statistically insignificant growth during feed restriction period. However weight of fish in treatment R_3 was significantly different ($p<0.05$) from control indicating it could not compensate the growth due to three weeks of restricted feeding. It was found that feed consumption was directly related with duration of restriction. There was significant difference ($p<0.05$) in feed consumption of R_1 and R_2 compared to control without any compromise with growth statistically. So, it can be inferred that one and two weeks of feed restriction can reduce the feed cost substantially without hampering the growth of fish.

The proximate composition of fish muscle such as crude protein, crude fat, total ash and NFE contents were estimated during beginning and termination of the experiment (Fig. 4). The moisture content in fish muscle was 76.54% initially and it varied from 75.24% in control to 76.89% in treatment R_3. It declined in different treatments except R_3 over initial values and it could be due to higher growth of a fish. Protein content was maximum in control and minimum in treatment R_3. There was significant difference ($t=4.237$, $p<0.05$) in protein content in R_3 compared to control which elucidated protein might have used for energy rather than growth causing less weight to fish.

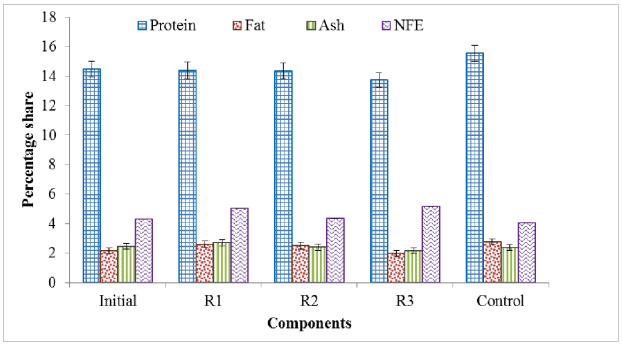

Fig. 4. Proximate composition of fish muscle (percent) under feed restriction

Lipid content follows the same trend of variation as that of protein in different treatments. It varied significantly ($t=4.718$, $p<0.05$) from control in treatment R_3 which can be attributed to its utilization for energy due to prolong feed restriction. The total ash content was relatively high in the treatment R_1 and R_2 compared to control. It was found that protein and fat content was relatively more in control compared to treatments which bears resemblance with earlier works (Gao, et al., 2015; Azodi et al., 2016; Ali et al., 2016). It might be due to mobilization of nutrients for energy purposes during the period of feed restriction (Zhu et al., 2005; Azodi et al., 2013). The present study indicated that feeding protocol with one and two weeks of feed restriction can reduce feed cost without hampering fish growth in fingerlings of *Labeo bata*.

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