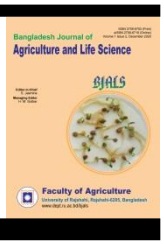
Original Article

Bangladesh Journal of Agriculture and Life Science
Faculty of Agriculture, University of Rajshahi
Rajshahi-6205, Bangladesh
Vol. 01(2): 21-27, 2020
http://dept.ru.ac.bd/bjals/



Effects of dietary vitamin C on the growth, carcass compositions and palatability of *Labeo bata*

Mahbuba Sultana, Md. Rony Hosen, Syeda Nusrat Jahan and Md. Mahabubur Rahman*

Department of Fisheries, University of Rajshahi, Rajshahi, Bangladesh

ARTICLE INFO

Article History

Received: July 20, 2021
Accepted: September 15, 2021
Online: September 30, 2022

Keywords
Vitamin C
Growth
Carcass
Nutrient
Odor and Taste

ABSTRACT

A study was conducted to investigate the effects of dietary vitamin C on the growth, carcass compositions and palatability of *Labeo bata* for three months. The study was carried out in 12 cages set in a pond of the Department of Fisheries, University of Rajshahi, Rajshahi under 4 treatments (T0, T1, T2 and T3) with 4 experimental feeds prepared by addition of vitamin C at the rate of 0 (Control), 100, 200 and 400 mg/Kg feed. During this study, the growth parameters (weight gain, SGR and survival rate), carcass compositions (Crude protein, lipid, fiber, carbohydrate, ash and moisture content) and palatability (Odor and taste) of the fish were measured by following standard methods. Significantly higher weight gain was recorded in T3 compared to other treatments. No significant difference found in SGR among the treatments but relatively higher SGR was recorded in T3. There were no significant differences among the treatments for the survival rate of the fish due to dietary vitamin C. A relatively higher carcass protein and lipid were estimated in the fish of T3 and T2, respectively. Moreover, carcass fiber, ash and carbohydrate content showed an increasing trend in the fish fed with vitamin C treated feed. The odor of cooked fish fed vitamin C treated feed was fresh and the taste was more or less sweet compared to the control fish. The present study concluded that dietary vitamin C at 400 mg/kg feed increased the growth and carcass protein of *L. bata*. Dietary vitamin C also affects the odor and taste of the fish.

Introduction

Aquaculture production has been increased due to the development and implementation of improved culture techniques and the extension of pond aquaculture (Alam and Thomson, 2001). Fish is the cheapest source of high-class protein for human nutrition worldwide-still with a gap in production and supply. Therefore, accelerating the development of the aquaculture industry is one of the important factors to produce more fish over the current production.

The production of fish can be increased to a great extent by boosting the culture practices through new approaches or technologies. The profitable fish production and quality of fish muscle principally depend upon the use of

***Address of correspondence**
Department of Fisheries
University of Rajshahi, Rajshahi, Bangladesh
E-mail: mratan1980@gmail.com (Md. Mahabubur Rahman)

nutritionally adequate feeds used for culture. However, the scaling up of fish culture has expanded the fish feed industry in different regions of Bangladesh. Unfortunately, most of the fish feed producers failed to meet up the standards for nutrients requirements, especially micronutrients like vitamins, minerals, etc.

Vitamins as essential micronutrients are required for the maintenance of the normal body functions of fish. The proper amount of vitamins are required for the normal metabolic processes within the enzymatic system which consists of a variety of enzyme activities linked with the metabolic, endocrine, and immune systems (Keen et al. 2004). The deficiency of those micronutrients causes many metabolic disorders and diseases through its negative influence on the physiological system in fish and other animals (Lin and Shiau, 2005). Vitamin C is a strong antioxidant and is considered one of the essential nutrients required for growth and immunity in fish (Khan et al. 2015). It plays an extensive role in the enhancement of growth, collagen synthesis, iron metabolism, hematology, reproduction, stress physiology, wound healing and immune response in fish (Anbarasu and Chandran, 2001). Vitamin C is essential and should be taken with food to maintain the physiological processes of fish because they lack the enzyme, L- gluconolactone oxidase that synthesizes vitamin C from glucose.

However, *Labeo bata* (Hamilton, 1822) is an important aquaculture species in our country due to its higher nutritive value and market demand. This minor carp species is more popular in the north-western part of Bangladesh and people of this area prefer most this fish to eat. It is omnivore in nature and can be cultured in feed-based aquaculture system. The growth, muscle quality and palatability of this species can be improved by enrichment of feed with the proper amount of vitamin C. Although, a number of researches have been done on the effects of dietary vitamin C on the growth, health condition and survival rate of different fish species in different parts of the world (Afrin and Rahman, 2019; Ahmed et al. 2018; Hoseinifar et al. 2014; Miar et al. 2013; Misra et al. 2007; Tewary and Patra, 2008) but, the researches on the effects of dietary vitamin C on the growth, carcass compositions and palatability of minor carp species are rare in Bangladesh. Therefore, the study was conducted to evaluate the effects of dietary vitamin C on the growth, carcass composition and palatability of *L. bata*.

Materials and Methods

Experimental site and period

The study was conducted in 12 cages (volume of each cage $4\times4\times4$ ft^3) set in a pond situated at the Northside of the Department of Fisheries, University of Rajshahi, Rajshahi, Bangladesh for a period of 3 months (from August to October, 2019).

Vitamin C used

Vitamin C named VITAMIX-C (The ACME Laboratories Ltd, Bangladesh) was collected from a local store (Salim Enterprise, Greater Road, Rajshahi). VITAMIX-C consists of 98 % of ascorbic acid.

Preparation of feeds

A commercial carp feed (City group) was used to prepare the experimental feeds. Three vitamin C enriched feeds were prepared by addition of vitamin C at a rate of 100, 200 and 400 mg/kg feed. The feeds were coded as F1, F2 and F3, respectively. A controlled feed (Feed without Vitamin C) was coded as F0. An optimum quantity of water was added into the feed to make it soft and malleable. Vitamin C was then added at a fixed rate and thoroughly mixed to make into a dough. The dough was extruded with a pelleting machine to convert it into pellets. Pellets were then dried and packed in labeled polythene bags, sealed and stored in refrigeration condition until used. The feed samples were sent to the laboratory for analyzing the chemical compositions. The analyzed data of four feeds are given in Table-1. There was no significant difference in the chemical compositions of the experimental feeds.

Experimental design

The experimental trial was conducted under 4 treatments (T0, T1, T2 and T3) with 4 types of feeds. Where, T0: Fish group fed feed without Vitamin C; T1: Fish group fed feed with Vitamin C at 100 mg/kg feed; T2: Fish group fed feed with Vitamin C at 200 mg/kg feed); and T3: Fish group fed feed with Vitamin C at 400 mg/kg feed.

Experimental fish

Fry of *L. bata* (initial mean weight 24.28±2.42 g) was purchased from a local fish farm. Fish were transferred by a van in a proper scientific way. Then the fish were acclimatized to the experimental condition for one week before the start of the experiment. During the acclimatization period, fish were fed a commercial carp feed at 5% of body

weight. After the acclimatization period, thirty-two fish fry were randomly released in each cage.

Feeding of fish

Fish were fed with the experimental feeds for 90 days; twice daily (in the morning at 9:30 am and in the afternoon at 4:30 pm) at a rate of 5 % of body weight. During the experimental period, fish were weighed fortnightly and the ration size was adjusted according to the body weight.

Monitoring of water quality parameters

During the study period, some water quality parameters such as temperature, dissolved oxygen, pH, total alkalinity and ammonium-nitrogen (NH_3-N) were measured fortnightly according to the standard methods. The water quality parameters data under four treatments are presented in Table-2. There was no significant variation in the water quality parameters among the treatments during the study period.

Table 1. Chemical composition of the experimental feeds

Component (%)	Experimental Feeds			
	T0	**T1**	**T2**	**T3**
Protein	23.33±2.18[a]	23.35±2.24[a]	23.36±2.08[a]	23.35±2.36[a]
Lipid	6.50±1.62[a]	6.36±1.16[a]	6.42±1.09[a]	6.35±1.30[a]
Ash	12.71±2.66[a]	12.67±2.51[a]	12.75±1.99[a]	12.78±2.08[a]
Fiber	7.28±1.81[a]	7.20±1.19[a]	7.12±1.30[a]	7.24±1.73[a]
Carbohydrate	38.06±4.31[a]	38.18±4.12[a]	38.07±4.29[a]	38.01±4.18[a]
Moisture	12.12±2.13[a]	12.24±2.17[a]	12.28±2.45[a]	12.27±2.37[a]

- T0: Feed without Vitamin-C. T1: Feed with Vitamin-C at 100 mg/kg feed; T2: Feed with Vitamin-C at 200 mg/kg feed; and T3: Feed with Vitamin-C at 400 mg/kg feed.
- Values in the same row with same superscripts are not significantly different ($p<0.05$).

Table 2. Water quality parameters during the study period

Parameters	**Treatments**			
	T0	**T1**	**T2**	**T3**
Temperature (˚C)	33.74±0.78[a]	34.16±0.62[a]	33.98±1.02[a]	34.12±0.41[a]
DO (mg/l)	6.20±0.58[a]	6.29±0.35[b]	6.42±0.34[a]	6.61±0.32[a]
pH	7.45±0.12[a]	7.42±0.18[a]	7.37±0.21[a]	7.42±0.16[a]
Alkalinity (mg/l)	152.68±5.54[a]	151.45±3.74[a]	154.83±4.06[a]	153.17±4.08[a]
NH_3-N (mg/l)	0.035±0.005[a]	0.033±0.004[a]	0.034±0.03[a]	0.036±0.003[a]

- Values in the same row with same superscripts are not significantly different ($p<0.05$).

Sampling and analysis of growth

The first sampling was done on the day of starting of experiment and weights of the fish from each cage were recorded. Then sampling was carried out fortnightly to record the weight of fish. The initial and final weights of fish in each group were measured individually. Weight gain, specific growth rate (SGR) and survival rate (SR) was calculated according to the standard method (Laird and Needham, 1988) as follows:

1. Weight gain (g) = final weight − initial weight
2. SGR (% bwd^{-1}) = 100 [{Ln (average terminal BW) − Ln (average initial BW)}/test] days
3. SR (%) = (number of fish at end of test/number of fish on first day of test) × 100

Collection of fish muscle

At the end of the experimental trial, 6 fish (20%) from each cage were sacrificed. Then the fish muscle samples were collected from different portions of the body and preserved in a frozen condition for subsequent analysis.

Chemical analysis of feed and fish muscle

The experimental feeds and fish muscle samples were transferred to the Nutrition Laboratory, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, Bangladesh to analyze the crude protein, lipid, fiber carbohydrate, ash and moisture contents according to the standard methods (AOAC, 2005).

Palatability test of fish muscles

The term, palatability means the acceptable to the taste and sufficiently agreeable in flavor or odor to be eaten of a food. For palatability test, the cleaned fish were cooked traditionally by using traditional spices. After consumption of cooked fish (Control and Vitamin C treated fish), the odor and taste were evaluated by consumer's (12) comments through a specific score on a score sheet. From the total score of the consumers, a rating remark was also made.

Statistical analysis

Statistical analysis of data was performed using one-way analysis of variance (ANOVA) followed by Duncan's multiple-range test. The significant difference levels were considered when $P<0.05$. The statistical analysis was performed by SPSS-19 (Statistical Package for Social Science) computer software (SPSS, USA).

Table 3. Growth parameters of the fish under four treatments

Parameters	Treatment			
	T0	T1	T2	T3
MIW (g)	24.31±3.73^a	24.28±2.42^a	24.30±3.16^a	24.25±2.42^a
MFW (g)	55.13±3.31^b	55.26±2.14^b	55.52±2.24^b	59.21±3.17^a
MWG (g)	30.82±2.42^b	30.98±2.28^b	31.22±2.92^b	35.04±2.75^a
SGR (% bwd^{-1})	0.90±0.11^a	0.91±0.07^a	0.93±0.11^a	0.99±0.09^a
SR(%)	73.93±2.68^a	74.62±3.12^a	74.63±2.37^a	76.56±2.56^a

- MIW = Mean Initial Weight, MFW = Mean Final Weight, MWG = Mean Weight Gain, SGR = Specific Growth Rate and SR = Survival Rate. Values in the same row with different superscripts are significantly different (*P<0.05*).

Results

Growth parameters

The mean values of different growth parameters under four treatments are presented in Table-3. The mean weight gains in the fish were estimated as 30.82±2.42, 30.98±2.28, 31.22±2.92 and 35.04±2.75 in T0, T1, T2 and T3, respectively. Significantly higher mean weight gain was recorded in T_3 (Feed with 400 mg vitamin C/kg feed) but there was no significant difference in the mean weight gain among the fish in T0, T1 and T2. The mean values of specific growth rate (SGR, % bwd^{-1}) were calculated as 0.90±0.11, 0.91±0.07, 0.92±0.11 and 0.99±0.09 in T0, T1, T2 and T3 respectively. SGR values showed no significant differences among four treatments. The mean survival rates of fish were calculated as 73.93±2.68, 74.62±3.12, 74.63±2.37 and 76.56±2.56 % in T0, T1, T2, and T3, respectively. There were no significant differences in the survival rate of the fish among the treatments but the highest survival rate of the fish was recorded in T3 and the lowest was found in T0.

Carcass compositions

The analyzed data of carcass compositions of the fish are given in Table-4. According to the results of the present study, there were no significant differences in the carcass compositions of fish among treatments but dietary vitamin C had positive effects on carcass compositions.

Palatability test

After consumption of cooked fish, a number of consumers made their comments on odor and taste of fish through the specific score on a score sheet and the mean scores are shown in Table-5. In the present study, it was observed that cooked fish muscle in T3 was ranked 1 according to the odor and taste scores given by the consumers.

Table 4. Carcass compositions of the fish under four treatments

Component (% wet basis)	Treatments			
	T0	T1	T2	T3
Crude Protein	16.42±.84[a]	16.45±0.66[a]	16.53±0.72[a]	16.55±0.58[a]
Crude Lipid	1.83±0.20[a]	1.96±0.17[a]	1.99±0.21[a]	1.93±0.19[a]
Crude Fiber	1.24±0.27[a]	1.29±0.13[a]	1.34±0.16[a]	1.33±0.11[a]
Carbohydrate	2.04±0.08[a]	2.12±0.12[a]	2.18±0.21[a]	2.20±0.10[a]
Ash	0.82±0.11[a]	0.86±0.09[a]	0.95±0.08[a]	0.89±0.10[a]
Moisture	77.65±1.15[a]	77.32±1.24[a]	77.01±1.14[a]	77.16±1.29[a]

- Values in the same row with same superscripts are not significantly different (*P<0.05*).

Discussion

Growth of the fish

From the result, it was observed that feed with a higher level of dietary vitamin C had positive effects on the body weight gain when compared to the control fish. The present findings are agreed with the finding of Ahmed et al. (2018) and Afrin and Rahman (2019) who recorded that rohu (*Labeo rohita*) fed with feed added with ascorbic acid showed better growth performance. The findings of the present study also agreed with the report of Nsonga et al. (2009) and Daniel et al. (2018) who found that juvenile tilapia (*Oreochromis karongae*) and juvenile striped catfish (*Pangasianodon hypophthalmus*) fed the feed with ascorbic acid had significant effects on better growth. Okhionkpamwonyi and Edema (2017) denoted that African Catfish (*Clarias gariepinus*) fed diets containing vitamin C had higher growth performance compared with those fed the control diet that is also supportive to the present study.

Generally, the higher value of SGR indicates the better weight gain of fish. In the present study, the fish group in T3 showed the maximum specific growth rate might be due to the addition of higher level of vitamin C in feed as compared to other treatments. The findings of the present study are more or less similar to the findings of Afrin and Rahman (2019) who found higher specific growth rate in *L. rohita* fed with 300 mg/kg feed. Daniel et al. (2017) found higher SGR in striped catfish (*Pangasianodon hypophthalmus*) juveniles with the addition vitamin C in feed that is supportive to the present study. The present study is also more or less similar to the findings of Rahman et al. (2018) in case of *L. rohita*.

The present results indicated that dietary vitamin C had positive effects on the survival rate. The findings of the present study are more or less similar to the report of Nsonga et al. (2009) who found survival rate of juvenile tilapia (*Oreochromis karongae*) as 77% in vitamin C enriched diet. The survival rate of the fish in the present study is also supported by the finding of Afrin and Rahman (2019) who stated that the supplementation of vitamin C in the diet had no significant effects on the survival rate of *Labeo rohita* but a higher survival rate found in dietary vitamin C treated fish. Misra et al. (2007) recorded more or less similar results to the present study.

Table 5. Mean scores of palatability test for cooked fish

SCORE						Mean score obtained			
10	8	6	4	2	0				
ODOR/FLAVOR						**T0**	**T1**	**T2**	**T3**
Species specific	Fresh fish	Slightly fishy or slightly sour	Sour and stale	Strong ammonia	Rotten smell	6.50 ± 1.03	8.33 ±1.14	8.67 ±0.97	8.83 ±1.11
TASTE						**T0**	**T1**	**T2**	**T3**
Meaty flavor	Sweet	Slightly fishy	Slightly sour/some off flavor	Slightly rotten	spoil	6.33 ± 0.87	7.17 ± 0.91	7.87 ± 0.97	8.50 ± 0.85
Total score obtained						13.83	15.50	16.54	17.83
Rating						**T0**	**T1**	**T2**	**T3**
						4	3	2	1

Carcass compositions of the fish

From the results, it was revealed that the carcass protein content was increased in the vitamin C treated fish compared to the control fish. Vitamin C is an essential coenzyme in certain oxidative processes, including the oxidation of tyrosine and phenylalanine (Ibiyo et al. 2007). The improvement of carcass protein in the fish was an indication of the importance of dietary vitamin C in body protein metabolism. Carcass protein content improvement due to dietary vitamin C was also observed in *Cyprinus carpio* (Faramarzi, 2012) and *Barbus sharpeyi* (Yousefi et al. 2013). In the present study, carcass lipid content also fluctuated at the time of rearing which might be due to the effects of dietary vitamin C at certain level on lipid metabolism. Tewary and Patra (2008) observed increased carcass lipid content in rohu (*Labeo rohita*) with the addition of vitamin C in the diet. Generally, moisture and lipid content have an inverse relationship (Wheeler and Morrissey, 2003) that is more or less supportive to the present study. Moreover, dietary vitamin C had no significant effects on carcass fiber, ash and carbohydrate content of *L. bata* but an increasing trend was observed with increasing level of dietary vitamin C in the feed. These results revealed that dietary vitamin C have positive role in mineral metabolism and deposition. Afrin and Rahman (2019) found more or less similar results in the case of *L. rohita*.

Palatability of the fish

From the results of this study, it was observed that the odor of cooked muscles in T3 was more or less species-specific and in T_1 and T_2 was fresh whereas in T_0 was slightly fishy. The taste of cooked muscles in T_3 was sweetened and in T1 and T2 was slightly sweet whereas in T_0 was slightly fishy. From the score sheet, it was also observed that the sweetness of fish was increased with the increasing levels of dietary vitamin C inclusion in the feed. The results of the present study revealed that the odor and taste of cooked fish were changed in the dietary vitamin C treated fish compared to the control fish which might be due to the relatively higher % of carcass protein and carbohydrate contents in the fish fed with vitamin C treated feed.

Conclusion

The present study concluded that dietary vitamin C at 400 mg/kg feed has better effects on the growth, carcass protein and, odor and taste of *L. bata*. Long-term studies are required to draw a more accurate conclusion on the effects of dietary vitamin C on the growth, carcass composition and palatability of the fish.

Acknowledgment

Financial support by the Rajshahi University Research Grant, Rajshahi, Bangladesh is gratefully acknowledged.

Authors' Contribution

Conceptualization, MS and MMR; Methodology, MS and MMR; Investigation, MS, MRH and MMR; Write-up, MS, MMR, SNJ: Supervision, MMR and SNJ. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest: The authors declare no conflict of interests.

References

Afrin S and Rahman MM (2019). Inclusion of Vitamin C in a Commercial Feed of *Labeo rohita* (H): Effects on Growth, Blood Parameters and Carcass Compositions, IOSR Journal of Agriculture and Veterinary Science 12(12): 53-58.

Ahmed M, Ferdous Z, Paul M, Rashid MH and Hossain MS (2018). Effect of dietary vitamin C on the growth and survival rate of rohu (*Labeo rohita*). Journal of Bioscience and Agriculture Research 16(02): 1375-1385.

Alam MF and Thomson KJ (2001). Current constraints and future possibilities for Bangladesh fisheries. Food Policy 26: 297-313.

Anbarasu K and Chandran MR (2001). Effect of ascorbic acid on the immune response of the catfish, *Mystus gulio* (Hamilton) to different bacterins of *Aeromonas hydrophila*. Fish and Shellfish Immunology 11(4): 47-55.

AOAC (2005). Association of Officials Analytical Chemists (Official methods of analysis, 18th ed. Association of Analytical Communities International, Arlington, Virginia, USA.

Daniel N, Muralidhar AP and Srivastava PP (2018). Dietary ascorbic acid requirement for growth of striped catfish, *Pangasianodon hypophthalmus* (Sauvage, 1878) juveniles. Aquaculture Nutrition 24: 616–624.

Faramarzi M (2012). Effect of dietary vitamin C on growth and feeding parameters, carcass

composition and survival rate of common carp (*Cyprinus carpio*). Global Veterinaria 8(5): 507-510.

Hoseinifar SH, Soleimani N and Ringo E (2014). Effects of dietary fructo-oligosaccharide supplementation on the growth performance, haemato-immunological parameters, gut microbiota and stress resistance of common carp (*Cyprinus carpio*) fry. British Journal of Nutrition 112: 1296-1302.

Ibiyo LMO, Atteh JO, Omotosho JS and Madu CT (2007). Vitamin C requirements of *Heterobranchus longifilis* fingerlings. African Journal of Biotechnology 6: 1559-1567.

Keen CL, Uriu AJY, Emsimsa JL and Gershwin ME (2004). Trace elements/minerals and immunity. Handbook of Nutrition and Immunity, Humana Press 117-140 pp.

Khan KU, Zuberi A and Ullah I (2015). Effects of graded level of dietary L-ascorbyl-2-polyphosphate on growth performance and some hematological indices of juvenile mahseer (*Tor putitora*), International Journal of Agriculture and Biology 17: 821-827

Laird LM and Needham T (1988). Growth, nutrition and feeding, salmon and trout farming, Ellis Horwood Limited, England 202-216 pp.

Lin Y and Shiau S (2005). Dietary selenium requirements of juvenile grouper (*Epinephelus malabaricus*). Aquaculture 250: 356-363.

Miar A, Matinfar A, Shamsaei M and Soltan M (2013). Effects of different dietary vitamin C and E levels on growth performance and hematological parameters in Rainbow Trout (*Oncorhynchus mykiss*). World Journal of Fish and Marine Sciences 5 (2): 220-226.

Misra CK, Das BK, Mukherjee SC and Pradhan J (2007). Effect of dietary vitamin C on immunity, growth and survival of Indian major carp, *Labeo rohita* fingerlings. Aquaculture Nutrition 13: 35-44.

Nsonga AR, Ombe JK, Mfitilodze W, Soko CK and Mtethiwa AH (2009). Effect of varying levels of dietary vitamin C on growth survival and hematology of juvenile tilapia, *Oreochromis Karongae* (Trewavas, 1941) reared in aquaria. Brazilian Journal of Aquatic Science and Technology 13(2): 17-23.

Okhionkpamwonyi ON and Edema CU (2017). Effects of Supplemental Vitamin C (Ascorbic Acid) on the Growth and Health of African Catfish *Clarias gariepinus*, Journal of Applied Science and Environmental Management 21 (1): 177-183.

Rahman MM, Rahman R and Chowdhury MM (2018). Evaluation of the Dietary vitamin C, E and Zinc supplementation on Growth performances and Survival Rate of Rohu, *Labeo rohita* (Hamilton, 1822). ISOR Journal of Agriculture and veterinary Science 11: 68-74.

Tewary A and Patra BC (2008). Use of vitamin C as an immune stimulant effect on growth nutritional quality and immune response of *Labeo rohita* (Ham). Fish Physiology and Biochemistry 34: 251-259.

Wheeler S and Morrissey MT (2003). Quantification and distribution of lipid, moisture and fatty acids of west coast albacore tuna (*Thunnu salalunga*). Journal of Aquatic Food Product Technology 12: 3-16.

Yousefi P, Yavari V, Zakeri M, Parviz SA and Keyvanshokooh S (2013). Effect of dietary supplementation of vitamin C on growth performance feed utilization and carcass composition of *Barbus sharpeyi* fingerlings. Journal of the Persian Gulf 4(14): 23-31