

## International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693  
 ISSN Online: 2617-4707  
 NAAS Rating (2026): 5.29  
 IJABR 2026; 10(7): 422-425  
[www.biochemjournal.com](http://www.biochemjournal.com)  
 Received: 02-05-2026  
 Accepted: 06-06-2026

**Dhruvi P Tandel**  
 College of Fisheries Science,  
 Kamdhenu University,  
 Veraval, Gujarat, India

**PV Parmar**  
 College of Fisheries Science,  
 Kamdhenu University,  
 Veraval, Gujarat, India

**Priya U Tandel**  
 College of Fisheries Science,  
 Kamdhenu University,  
 Veraval, Gujarat, India

**Binal A Tandel**  
 College of Fisheries Science,  
 Kamdhenu University,  
 Veraval, Gujarat, India

## Immunostimulatory effect of *Glycyrrhiza glabra* root powder on growth and survival of *Labeo rohita*

**Dhruvi P Tandel, PV Parmar, Priya U Tandel and Binal A Tandel**

**DOI:** <https://www.doi.org/10.33545/26174693.2026.v10.i7f.9038>

### Abstract

The present study was conducted to evaluate the effects of dietary licorice (*Glycyrrhiza glabra*) root powder on the growth performance and survival of *Labeo rohita*. A 60-day feeding trial was carried out using 300 fingerlings distributed among five dietary treatments containing different levels of licorice root powder @ 0% (control), 0.25%, 0.5%, 0.75% and 1% feed. The fish were reared under controlled conditions and fed experimental diets containing 30% crude protein. Growth performance was assessed in terms of final body weight, weight gain, feed conversion ratio (FCR), specific growth rate (SGR) and survival rate. The results indicated significant improvements ( $p < 0.05$ ) in growth and survival parameters with increasing levels of licorice supplementation. Fish fed the diet containing 1% licorice root powder exhibited the highest final body weight ( $4.66 \pm 0.017$  g), weight gain ( $3.19 \pm 0.017$  g), specific growth rate ( $1.92 \pm 0.017$ ), and survival rate ( $95.00 \pm 3.191$ ), along with the lowest feed conversion ratio ( $1.93 \pm 0.022$ ). The control group recorded the lowest performance for all growth indices and survival percentage. The findings of the present study demonstrate that dietary inclusion of *Glycyrrhiza glabra* root powder, particularly at 1% feed, can effectively enhance growth performance and survival of *Labeo rohita*. Therefore, licorice root powder may serve as a natural and eco-friendly feed additive for improving productivity in freshwater aquaculture.

**Keywords:** *Glycyrrhiza glabra*, *Labeo rohita*, growth performance, feed additive, survival, aquaculture

### 1. Introduction

Aquaculture is one of the fastest-growing food production sectors in the world and plays an important role in ensuring global food security, nutritional improvement and economic development. Despite a reduction in capture fisheries production, aquaculture has continued to expand rapidly due to the adoption of improved and intensive farming practices (FAO, 2018) [9]. Global fish production from capture fisheries and aquaculture has increased considerably from 19 million tonnes in 1950 to approximately 178 million tonnes in 2022. In recent year aquaculture contributing nearly 52% of the total production (FAO, 2025) [11]. The continuous increase in aquaculture production reflects its significant contribution to meeting the rising global demand for aquatic food.

In India, freshwater aquaculture is mainly dominated by Indian major carps, including *Labeo rohita*, *Catla catla*, and *Cirrhinus mrigala*, which account for nearly 70% of the total aquaculture production. Among these species, *Labeo rohita* (rohu) is one of the most economically important freshwater fishes due to its rapid growth, excellent flesh quality, high consumer preference and wide adaptability to different culture systems (FAO, 2019) [9]. The rapid expansion of intensive aquaculture has improved fish production; however, it has also increased environmental and physiological stress in cultured fish, which can negatively affect growth, health and immune functions. Disease outbreaks remain a major challenge in aquaculture and often lead to significant economic losses worldwide (Sahoo *et al.*, 2011) [14]. Traditionally, antibiotics and chemical agents have been applied for disease prevention and health management in aquaculture (Stoskopf, 1993) [16]. However, the excessive and indiscriminate use of these substances has resulted in several concerns, including antimicrobial resistance (AMR), bioaccumulation, environmental toxicity and potential risks to human health (Cheng *et al.*, 2008) [5]. Therefore, the search for natural, safe and environmentally friendly alternatives has gained considerable attention in modern aquaculture.

**Corresponding Author:**  
**Dhruvi P Tandel**  
 College of Fisheries Science,  
 Kamdhenu University,  
 Veraval, Gujarat, India

Medicinal plants and herbal products have emerged as promising natural feed additives due to their immunostimulatory, antioxidant, antimicrobial and growth-promoting properties (Van Hai, 2015). These plants contain various bioactive compounds, including flavonoids, alkaloids, phenolics, polysaccharides, terpenoids, essential oils, tannins, pigments, polypeptides and steroids, which contribute to improved health and physiological performance of aquatic animals (Citarasu, 2010) [6]. The incorporation of medicinal plants and their extracts into fish diets has been reported to enhance growth performance, strengthen immune responses and improve the overall health status of various fish species (Yousefi *et al.*, 2019; Abdel-Tawwab *et al.*, 2020) [19, 3].

*Glycyrrhiza glabra* (licorice), commonly known as mulethi, is an important medicinal plant belonging to the family Fabaceae and has been widely used in traditional medicine due to its diverse pharmacological activities (Yin *et al.*, 2011) [18]. The roots of licorice contain several biologically active compounds such as glycyrrhizin, glabridin, liquiritin, liquiritigenin, and flavonoids. Among these, glycyrrhizin is considered the principal active compound responsible for many of its therapeutic properties, including antioxidant, anti-inflammatory, antimicrobial, hepatoprotective and immunomodulatory effects (Jiang *et al.*, 2012) [12].

The use of *Glycyrrhiza glabra* as a dietary supplement provides a sustainable and eco-friendly approach to improve fish health while reducing dependence on synthetic chemicals and antibiotics. As a natural feed additive, licorice can support better growth and improve the overall physiological condition of cultured fish. Therefore, the present study was undertaken to evaluate the effects of *Glycyrrhiza glabra* root powder supplementation on the growth performance and survival of *Labeo rohita*.

## 2. Materials and Methods

The experiment was conducted at the Wet Lab Training Centre, College of Fisheries Science, Veraval, to evaluate the effects of *Glycyrrhiza glabra* root powder on the growth and survival of *Labeo rohita*. The feeding trial was carried out for 60 days from October to December 2025. A total of 20 rectangular plastic tanks (2 × 1 × 1 feet) were used for the experiment. The tanks were thoroughly cleaned, disinfected using potassium permanganate (KMnO<sub>4</sub>), and filled with approximately 40 L of filtered freshwater with continuous aeration. Healthy *Labeo rohita* were collected from a nearby hatchery and transported to the experimental facility. The fish were acclimatized in a 500 L FRP tank under suitable feeding and aeration conditions for seven days. After acclimatization, a total of 300 fish were randomly distributed among the experimental tanks, with 15 fish stocked in each tank for the study.

### 2.1 Procurement of Feed Ingredients

Different ingredients including fish meal, groundnut oil cake, tapioca flour, wheat flour, fish oil, plant oil, licorice (*Glycyrrhiza glabra*) root powder and a vitamin-mineral premix were utilized for the preparation of the experimental diets. All ingredients were procured from local markets. The collected ingredients were finely ground and passed through a sieve to achieve a uniform particle size. After sieving, they were stored in polythene bags at room temperature until further use.

## 2.2 Experimental diet preparation

Five experimental diets (T<sub>0</sub> to T<sub>4</sub>) were formulated using the Pearson square method according to the different treatment groups. The diets T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> were supplemented with varying levels of licorice (*Glycyrrhiza glabra*) root powder, while the control diet (T<sub>0</sub>) was prepared without the inclusion of licorice root powder. The required quantities of feed ingredients inclusion of licorice root powder. The required quantities of feed ingredients were accurately weighed as per the feed formulation presented in Table 1 and mixed thoroughly. A suitable amount of water was added to the mixture to prepare a homogeneous dough. The dough was then subjected to heat treatment at 121 °C under 15 lbs pressure for 15 minutes.

Following the steaming process, licorice root powder along with vitamin and mineral premix was added and mixed uniformly. The final mixture was processed into pellets using a mechanical pelletizer. The prepared pellets were sun-dried until their moisture content was reduced to below 10% to ensure proper storage. Finally, the dried pellets were packed in airtight, labeled plastic containers and sealed until further use.

**Table 1:** Composition of experimental diets

| Ingredients (%)      | Diet (30% protein) |                |                |                |                |
|----------------------|--------------------|----------------|----------------|----------------|----------------|
|                      | T <sub>0</sub>     | T <sub>1</sub> | T <sub>2</sub> | T <sub>3</sub> | T <sub>4</sub> |
| Licorice root powder | 0                  | 0.25           | 0.5            | 0.75           | 1              |
| Fish meal            | 38                 | 38             | 38             | 38             | 38             |
| GNOC                 | 28                 | 28             | 28             | 28             | 28             |
| Wheat flour          | 15                 | 15             | 15             | 15             | 15             |
| Tapioca flour        | 13                 | 12.75          | 12.50          | 12.25          | 12             |
| Plant oil            | 2                  | 2              | 2              | 2              | 2              |
| Fish oil             | 2                  | 2              | 2              | 2              | 2              |
| Vitamin& mineral     | 2                  | 2              | 2              | 2              | 2              |
| Total                | 100                | 100            | 100            | 100            | 100            |

### 2.3 Growth Performance Analysis

- Body weight gain (g) = (Final body weight-Initial body weight)
- FCR (Feed conversion ratio) = Amount of feed given/Body Weight gain
- SGR (Specific growth rate) =  $\ln [(Final\ body\ weight)-\ln (Initial\ body\ weight)] \times 100/\text{days of the experiment}$
- Survival rate% = (No. of fish survived/No. of fish stocked) × 100

### 2.4 Analysis of water quality parameters

Throughout the experimental period, the physicochemical characteristics of water, including dissolved oxygen, hardness, temperature and pH, were monitored on a weekly basis. Dissolved oxygen and hardness were estimated using standard titration methods. Water temperature was measured using an electronic thermometer, while pH was determined with the help of a pH indicator.

### 2.5 Statistical Analysis

The collected data were statistically analyzed using standard methods as described by Snedecor and Cochran (2014) [15].

## 3. Results and Discussion

### 3.1 Effects of Licorice root powder on the growth and survival of *Labeo rohita*

At the beginning of the study, the average body weights of fish in treatments T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub> were 1.43±0.019,

1.46±0.021, 1.43±0.017, 1.45±0.020, and 1.47±0.016 g, respectively.

Following the end of the experimental period, the average final weights increased to 3.64±0.023, 3.87±0.025, 4.02±0.030, 4.31±0.017, and 4.66±0.017 g in treatments T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub>, respectively.

The mean weight gain over the 60-day experimental period was 2.17±0.023 g in T<sub>0</sub>, 2.40±0.024 g in T<sub>1</sub>, 2.55±0.030 g in

T<sub>2</sub>, 2.84±0.016 g in T<sub>3</sub>, and 3.19±0.017 g in T<sub>4</sub>. Statistical evaluation indicated significant differences ( $p < 0.05$ ) among all treatment groups. The control group (T<sub>0</sub>) exhibited the lowest weight gain, while treatment T<sub>4</sub> recorded the highest value, followed by T<sub>3</sub>, T<sub>2</sub>, and T<sub>1</sub>. These observations suggest that the dietary inclusion positively affected growth and that T<sub>4</sub> yielded the best growth response among all treatments.

| Treatment      | Mean weight (g)         | Mean weight gain (g)    | Feed conversion ratio (FCR) | Specific growth rate (SGR) | Survival Rate (%)         |
|----------------|-------------------------|-------------------------|-----------------------------|----------------------------|---------------------------|
| T <sub>0</sub> | 3.64±0.023 <sup>e</sup> | 2.17±0.023 <sup>e</sup> | 2.50±0.036 <sup>d</sup>     | 1.55±0.020 <sup>d</sup>    | 76.66±1.924 <sup>d</sup>  |
| T <sub>1</sub> | 3.87±0.025 <sup>d</sup> | 2.40±0.024 <sup>d</sup> | 2.29±0.036 <sup>c</sup>     | 1.62±0.033 <sup>d</sup>    | 80.00±0.000 <sup>cd</sup> |
| T <sub>2</sub> | 4.02±0.030 <sup>c</sup> | 2.55±0.030 <sup>c</sup> | 2.13±0.024 <sup>c</sup>     | 1.72±0.025 <sup>c</sup>    | 85.00±1.666 <sup>bc</sup> |
| T <sub>3</sub> | 4.31±0.017 <sup>b</sup> | 2.84±0.016 <sup>b</sup> | 2.05±0.024 <sup>b</sup>     | 1.81±0.029 <sup>b</sup>    | 91.66±3.191 <sup>ab</sup> |
| T <sub>4</sub> | 4.66±0.017 <sup>a</sup> | 3.19±0.017 <sup>a</sup> | 1.93±0.022 <sup>a</sup>     | 1.92±0.017 <sup>a</sup>    | 95.00±3.191 <sup>a</sup>  |

Similar results were reported by Abdel-Tawwab *et al.* (2021) <sup>[2]</sup> in Nile tilapia, where dietary inclusion of 1% licorice (*Glycyrrhiza glabra*) root powder enhanced growth performance, particularly weight gain and specific growth rate. The growth-promoting effects of licorice may be attributed to its abundance of bioactive compounds such as triterpene saponins, flavonoids, isoflavonoids, coumarins, and phenolic substances. These constituents are believed to enhance nutrient digestion and feed utilization, resulting in improved fish growth. Likewise, Elabd *et al.* (2016) <sup>[8]</sup> observed in yellow perch that supplementation of 10 g/kg licorice root powder significantly improved growth performance compared with the control diet.

After 60 days of feeding, the feed conversion ratio showed differences among the experimental groups, with values of 2.50±0.036, 2.29±0.036, 2.13±0.024, 2.05±0.024, and 1.93±0.022 recorded for T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub>, respectively. Statistical analysis of the feed conversion ratio (FCR) revealed significant differences among the treatment groups. The lowest FCR value was recorded in T<sub>4</sub>, followed by T<sub>3</sub>, T<sub>2</sub>, T<sub>1</sub>, and T<sub>0</sub>. Among all treatments, T<sub>4</sub> exhibited the most efficient feed utilization, as indicated by its significantly lower FCR compared to the other groups. The results suggest that dietary supplementation positively influenced feed conversion efficiency, with T<sub>4</sub> being the most effective treatment during the 60-day feeding trial. Similar finding was reported by Dubey *et al.* (2018) <sup>[7]</sup> demonstrated that supplementation with licorice root powder improved growth performance, maximum weight gain and specific growth rate along with a reduced FCR. Supporting these observations, Adineh *et al.* (2021) <sup>[4]</sup> significantly improved feed conversion efficiency in common carp fed licorice-supplemented diets.

The specific growth rate (SGR) of fish varied among the dietary treatment groups during the 60-day feeding trial. At the end of the experimental period, the SGR values recorded were 1.55±0.020 in T<sub>0</sub>, 1.62±0.033 in T<sub>1</sub>, 1.72±0.025 in T<sub>2</sub>, 1.81±0.029 in T<sub>3</sub>, and 1.92±0.017 in T<sub>4</sub>.

The results indicated clear differences in growth performance among the treatments. Treatment T<sub>4</sub> exhibited the highest SGR, followed by T<sub>3</sub>, T<sub>2</sub>, and T<sub>1</sub>, whereas the lowest SGR was observed in the control group (T<sub>0</sub>). Findings from the present study are in agreement with those reported by Abdel-Tawwab *et al.* (2021) <sup>[2]</sup>, who investigated the effects of licorice root powder as a natural dietary supplement on the growth performance and feed utilization of Nile tilapia (*Oreochromis niloticus*). Their study revealed that fish fed a diet supplemented with 1% licorice root powder exhibited the highest specific growth

rate (SGR) compared to the control group. Similarly, Abbas *et al.* (2017) <sup>[1]</sup> observed that the inclusion of 0.8% licorice root powder in the diet of common carp (*Cyprinus carpio*) significantly improved SGR, further confirming the growth-promoting potential of licorice as a dietary feed additive in aquaculture.

The survival rate of *Labeo rohita* varied among the dietary treatment groups during the experimental period. At the end of the study, the survival percentages recorded in T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> were 76.66±1.924, 80.00±0.000, 85.00±1.666, 91.66±3.191 and 95.00±3.191, respectively. The supplemented treatments exhibited higher survival rates compared to the control group (T<sub>0</sub>). Among all the treatments, the highest survival percentages were observed in T<sub>4</sub> and T<sub>3</sub>, whereas the lowest survival was recorded in T<sub>0</sub>. These findings suggest that dietary supplementation positively influenced the health condition of the fish and contributed to improved survival throughout the experimental period. Comparable results were documented by Abdel-Tawwab *et al.* (2021) <sup>[2]</sup> in Nile tilapia (*Oreochromis niloticus*), who reported significant improvements in survival rate, feed conversion efficiency, weight gain, and specific growth rate following dietary supplementation with licorice root powder ( $p < 0.05$ ). These findings are consistent with the present study, where the highest survival percentage was recorded in fish receiving a diet supplemented with 1% licorice.

#### 4. Conclusion

The present study investigated the immunostimulatory effects of *Glycyrrhiza glabra* root powder on *Labeo rohita*. The findings demonstrated that dietary supplementation with 1% licorice root powder (LRP) was the most effective level for enhancing the growth performance including, mean weight, mean weight gain, feed conversion ratio (FCR) and specific growth rate (SGR). Significant differences in survival rate were recorded among the treatment groups, indicating that the inclusion of licorice root powder in the diet had no adverse effects on fish survival. Overall, the study concluded that supplementation of 1% LRP in the diet effectively improved growth performance and survival in *Labeo rohita*.

#### References

1. Abbas KMAKA, Yahya FAS, Mohamad SD. Effect of adding licorice *Glycyrrhiza glabra* roots powder on growth parameters and blood indicators of common carp *Cyprinus carpio* L. 2017.

2. Abdel-Tawwab M, El-Araby DA. Immune and antioxidative effects of dietary licorice (*Glycyrrhiza glabra* L.) on performance of Nile tilapia, *Oreochromis niloticus* (L.) and its susceptibility to *Aeromonas hydrophila* infection. *Aquaculture*. 2021;530:735828.
3. Abdel-Tawwab M, Hamed HS. Antagonistic effects of dietary guava (*Psidium guajava*) leaves extract on growth, hemato-biochemical, and immunity response of cypermethrin-intoxicated Nile tilapia, *Oreochromis niloticus*, fingerlings. *Aquaculture*. 2020;529:735668.
4. Adineh H, Naderi M, Yousefi M, Khademi Hamidi M, Ahmadifar E, Hoseini SM. Dietary licorice (*Glycyrrhiza glabra*) improves growth, lipid metabolism, antioxidant and immune responses, and resistance to crowding stress in common carp, *Cyprinus carpio*. *Aquaculture Nutrition*. 2021;27(2):417-426.
5. Cheng YB, Pan TS, Hou GJ, Shi PS, Cao YH, Wang YJ. Effect of different Chinese medicinal herbal additives on the growth and prevention of the liver and gall syndrome in grass carp (*Ctenopharyngodon idella*). *Anhui Agricultural Science Bulletin*. 2008;14:146-155.
6. Citarasu T. Herbal biomedicines: A new opportunity for aquaculture industry. *Aquaculture International*. 2010;18(3):403-414.
7. Dubey MK, Anita A, Chauhan RS. Study of growth promoting and immunostimulatory effect of phytobiotic *Glycyrrhiza glabra* on fingerlings of *Cyprinus carpio haematopterus*. *Indian Journal of Geo Marine Science*. 2018;47(6):1180-1184.
8. Elabd H, Wang HP, Shaheen A, Yao H, Abbass A. Feeding *Glycyrrhiza glabra* (liquorice) and *Astragalus membranaceus* alters innate immune and physiological responses in yellow perch (*Perca flavescens*). *Fish & Shellfish Immunology*. 2016;54:374-384.
9. Food and Agriculture Organization. The State of World Fisheries and Aquaculture 2018. Rome: FAO; 2018.
10. Food and Agriculture Organization. Yearbook of Fishery and Aquaculture Statistics. Rome: FAO; 2019.
11. Food and Agriculture Organization. Fishery and Aquaculture Statistics: Yearbook 2023. Rome: FAO; 2025.
12. Jiang GZ, Liu WB, Li GF, Wang M, Li XF. Effects of different dietary glycyrrhetic acid levels on growth, body composition and plasma biochemical index of juvenile channel catfish, *Ictalurus punctatus*. *Aquaculture*. 2012;338-341:167-171.
13. Kumar S, Prakash C, Chadha NK, Gupta SK, Jain KK, Pandey PK. Effects of dietary alginic acid on growth and haemato-immunological responses of *Cirrhinus mrigala* (Hamilton, 1822) fingerlings. *Turkish Journal of Fisheries and Aquatic Sciences*. 2019;19(5):373-382.
14. Sahoo PK, Rauta PR, Mohanty BR, Mahapatra KD, Saha JN, Rye M, et al. Selection for improved resistance to *Aeromonas hydrophila* in Indian major carp *Labeo rohita*: Survival and innate immune responses in first generation of resistant and susceptible lines. *Fish & Shellfish Immunology*. 2011;31(3):432-438.
15. Snedecor GW, Cochran WG. Statistical Methods. 8th ed. Ames (IA): Wiley-Blackwell; 2014. p. 491.
16. Stoskopf MK. Fish Medicine. 1st ed. Philadelphia (PA): W.B. Saunders Co.; 1993. p. 882.
17. Van Hai N. The use of medicinal plants as immunostimulants in aquaculture: A review. *Aquaculture*. 2015;446:88-96.
18. Yin G, Cao L, Xu P, Jeney G, Nakao M, Lu C. Hepatoprotective and antioxidant effects of *Glycyrrhiza glabra* extract against carbon tetrachloride (CCl<sub>4</sub>)-induced hepatocyte damage in common carp (*Cyprinus carpio*). *Fish Physiology and Biochemistry*. 2011;37(1):209-216.
19. Yousefi M, Hoseini SM, Vatnikov YA, Kulikov EV, Drukovsky SG. Rosemary leaf powder improved growth performance, immune and antioxidant parameters, and crowding stress responses in common carp (*Cyprinus carpio*) fingerlings. *Aquaculture*. 2019;505:473-480.