Effect of dietary *Houttuynia cordata* leaf meal on the growth performance of silver carp (*Hypophthalmichthys molitrix)* fingerlings

**Abstract**

A 45‐day feeding trial was conducted to evaluate the effects of feeding *Houttuynia cordata* (fish mint) leaf meal on the growth performance in *H. molitrix* fingerlings. Four experimental diets were developed, incorporating different levels of fish mint (*H. cordata*) leaves (0%, 3%, 6%, and 9%) to three treatment groups and one control group. Each treatment has three replications. Growth performance indicators, including weight gain, percent weight gain, Length gain, specific growth rate, feed conversion ratio, were evaluated. Findings revealed that incorporating fish mint leaves in the diet had a significant impact on growth performance. Silver carp fed with 6 per cent treatment T3 fish mint leaves exhibited the highest average weight gain (49.2d±0.166g), percent weight gain (52.8c±1.301g), length gain (17.8a±1.154) and specific growth rate (0.86d±0.005), with improved feed conversion ratio (3.18a±0.024). Conversely, 3 and 9 percent concentrations of fish mint leaves showed reduced growth performance, indicating potential negative effects at higher inclusion levels.

 **Keywords**: Ingredient, Microorganism, Extruded, Pelleted and Microorganism

**Introduction**

Fisheries play a crucial role in several aspects of human life, serving as a vital source of food, nutrition, employment, and livelihood. Generally, these productions provision approximately 28 million fishermen and fish farmers, with an additional 50 million people engaged in the value chain. In terms of production, India is a major maritime state and an important aquaculture country in the world. Being home for more than 10 per cent of global fish diversity, India ranks third-largest fish-producing country in the world. Notably, India accounts for 16 per cent of global inland fish production 5 per cent of global marine fish production. India contributes almost 8.92 percent of fish production standing 3rd position globally and 2nd position in aquaculture. In 2022-2023, the total fish production obtaining 175.45 lakh tonnes, with marine fish production of 44.32 lakh tonnes and inland fish production of 131.13 lakh tonnes**.** Andhra Pradesh has always been the topmost production state of fish in India, followed by West Bengal, the second, and so forth. Andhra Pradesh has mostly been from inland fish production, whereas Karnataka has come first in marine fish production in 2022-23 (**FAO, 2024**)

Fish mint is a plant under the family Saururaceae and is native to the mountainous region of Eastern Asia, which has medicinal properties. It is distributed in Bhutan, China, Indonesia, Japan, Korea, Myanmar, Nepal, Thailand, Taiwan, Vietnam, North‐West Himalayan region and North‐East Region of India and is known by different local names, viz. Fish mint, Fish wort, Chameleon, Lizard's tail and fishy smell plant **(Tutupalli & Chaubal, 1974**). The herb is used as folk medicine as it has antiviral, antibacterial, immuno‐stim‐ ulant, diuretic, anti‐cancer and anti‐inflammatory effects **(Kumar, Prasad, and Hemalatha, 2014**). This plant use to treat digestive issues, insect bites, fevers, coughs and this plant used as vegetable or fresh herb, and fish mint root can also be eaten. This plant appears to have immense potential for the growth promoting properties in fish. The research on pig is proven that the fish mint leaf meal and extract in the diet act as a growth promoter. A diet containing the herb fish mint fed to Pacific white‐legged shrimp and cobia improved the growth and delayed the onset of any disease observed that giving fish mint in carp feed resulted in more intestinal favourable bacteria and thus eliminating the disease‐causing non‐prominent bacteria from the intestine.

 Silver Carp (*H. molitrix*) was introduced to aquaculture facilities in the southern United States from eastern Asia in the 1970s (**Kolar *et al., 2*005**). In India silver carp introduced in the year 1969 primarily controlling submerge vegetation. This introduction aimed to harness the Silver carp's filter-feeding abilities to maintain water quality and reduce the need for chemical treatments. In recent year this fish widely popular because of their higher growth rate compare to Indian major carps. In poly culture system, silver carp usually stock because they are filter feeder and their high growth rate.

Based on various studies highlighting the growth-promoting effects of herbs in fish, this study aimed to evaluate the impact of fish mint leaf meal on the growth performance *H. molitrix.*

**2. MATERIALS AND METHODS**

**2.1 Experiment Site**

 The research work was done in the laboratory Department of Aquaculture, School of Agriculture, Sanjeev Agarwal Global Education (S.A.G.E) University, Bhopal, and M.P.

**2.2 Collection of Ingredients**

Fish mint leaves were collected from the North Taibandal, Sepahijala, and Tripura, India. The collected fish mint leaves were washed with tap water to remove debris and air dried under shade. After complete drying, the HC leaf was powdered using a warring blender. A plastic container was use for storing the leaves powder for further use. All the other ingredients used in the feed making (rice bran, MOC, wheat flour, fish meal) and the vitamin premix were purchased from the local Baagsewaniya market, Bhopal.

**2.3 Procuring and acclimation of experimental Fish**

Fingerlings of silver carpfingerlings were sourced from Prayash fish farm, chandpura, Narmada Puram, Bhopal, M.P, India. They were then transported to the laboratory Department of the Aquaculture, School of Agriculture, S.A.G.E University, Bhopal, and M.P.Upon arrival, the fish underwent a brief salt treatment (20 g/L for 2 minutes) to help reduce stress and eliminate potential parasites. They were then left undisturbed overnight to recover.For the next 15 days, the fish were acclimated in a 2,000-liter aerated FRP tank. During this period, they were fed a control diet containing 35 per cent crude protein and 5 per cent body weight, twice daily, until satiated.

**2.4 Diet Formulation**

For the preparation of experimental diets all the ingredients were (fish meal, rice bran, mustard oil cake, wheat flour, vitamin premix; 34:25:25:15:1) finely powdered and it were mixed all together according to the percentage amount calculation of the ingredient with water, vitamin was added in all the three feeds including the control tank. The feed was formulated with 35 per cent protein content that is 3, 6 and 9 percent of fish mint leaves added. After complete mixing the dough the different treatment feed was put in an autoclave for 30 minutes to kill the microorganism. The autoclaved dough was added with vitamin premix and after complete mixing the dough feed were put in a feed pelletizer and extruded according to the required size for the fingerling fish mouth. Extruded pelleted feed are then dried at 40 0C for four hours to remove the moisture from the feed. The control feed used contains 0 per cent fish mint leaves, for the three treatment tanks, three different percentages of curry leaves are used to prepare the other three experimental diets, for the control experiment, feed containing fish meal, wheat flour, mustard oil cake (MOC) and rice barn as the ingredients was used.

**Table 1: Experimental Diet Composition**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.No.** | **Ingredients (g/Kg)** | **C** | **T1 (3% FM)** | **T2 (6%FM)** | **T3 (9%FM)** |
| **1** | **Fish Meal** | 127.75 | 127.75 | 127.75 | 127.75 |
| **2** | **Rice Brand** | 93.75 | 91.17 | 88.12 | 85.55 |
| **3** | **Wheat Flour** | 56.25 | 56.25 |  56.25 | 56.25 |
| **4** | **Vit. Premix** | 3.27 | 3.27 | 3.27 | 3.27 |
| **5** | **MOC** | 93.75 | 93.75 | 93.75 | 93.75 |
| **6** | **Fish Mint Powder** | 0 | 2.81 | 5.86 | 8.43 |
| **Total** | 375gm | 375gm | 375gm | 375gm |

**2.5 Experimental Set-up**

 The experiment was led for complete 45 days, for the experiment total 12 tanks were used with one control and three treatments with three for each treatment, in the control tank 0% (C) of fish mint were fed with 3 % of fish mint leaves in (T1) tank, 6 % of fish mint leaves in (T2), and 9 % of fish mint leaves in (T3) the feeding was done twice in a day, at the morning (9.00 am) and evening (5.00 pm), the fish was fed @ 3 per cent of the body weight. The water holding capacity of tank was 200 L with 1 diameter area of each tank. Before the stocking of fingerlings the tanks were disinfected properly with the use of potassium permanganate solution (Kmn04) and NaCl solution. The water source for the experiment was taken from water pump for the whole experimental period. The tank was then filled with water all of 12 tanks then the fingerlings were stocked measuring the weight and length 5 fingerlings in each tank. Aeration was provided in all 12 tanks to maintain the water oxygen level to avoid any stress to the fish. Water parameters were checked after 15 days as well the weight of the fish.

**2.6 Growth Parameters**

The following formulas were used to calculate the fish's growth performance.

1. **Weight gain (g)** = Final Weight (g) – Initial weight (g)
2. **Percent Weight Gain** = (Final weight gain – Initial weight gain / Initial weight gain) ×100
3. **Length gain (g)** = Final length gain(g) – Initial Length gain(g)

 4. **Specific Growth Rate (SGR)**

 SGR$=\frac{(lnWt-InWo)}{D}x100$

 **Where,**

 In= log

 W0 = Initial weight of live fish (gm)

 Wt = Final weight of live fish (gm)

 D = Duration of feeding (days)

 5. **Feed Conversion Ratio (FCR):** -

 FCR = Feed given (g) / Weight gain (g)

**2.7 Statistical Data Analysis**

 The growth performance metrics, including mean, NWG, PWG, LG, SGR and FCR, and were identified their significant differences among the groups. The data obtained from this study were analysed using the Statistical Package for the Social Sciences (SPSS). To compare the treatment effects, Duncan's post-hoc test was applied, and the data were presented as mean ± SE. Results will be considered statistically significant at the 5 per cent level (*p< 0.05*).

**3.0 Result and Discussion**

The effects of incorporating the fish mint leaves to silver carp (*H. molitrix*) diet were carefully examined, resulting in progressive weight gain across all treatments throughout the study duration. By adding fish mint powder at various concentrations and feeding it at 3% of the body weight, the study recorded continuous weight gain across all treatments. The chapter also presents detailed data on the LG, NWG, PWG, SGR, FCR and various growth performance parameters of (*H. molitrix*) fed these diets, beside growth performance analysed by weighing the silver carp at regular 15-day intervals.

The growth parameters of current study were recorded after two weeks. The fish were not fed on the day of the sampling. At the end of experiment, the relationship between LG, NWG, PWG, SGR and FCR were significantly (p<0.05) impacted by the diet that used of fish mint powder. The maximum growth parameters (LG, NWG, PWG and SGR) were observed in treatment T2 followed by T1 and T3 whereas the lowest was control group. The highest LG value (*p<0.05*) was observed in fish diet T2 (17.8a±1.154), followed by T1 and T3 and lowest (*p<0.05*) in fish fed control. The highest NWG value (*p<0.05*) was observed in fish diet T2 (49.2d±0.166), followed by T1 (40.7c±0.000**)** and T3 (34.8b±0.333), with the lowest (p<0.05) in the fish fed diet control (32.5a±0.000). The highest PWG value (*p<0.05*) was observed in fish diet T2 (52.8c±1.301) followed by T1 (42.3b±1.154) and T3 (36.4a±0.881), with the lowest (*p<0.05*) in the fish fed diet control (38.7ab±1.154). The highest SGR value (p<0.05) was observed in fish diet T2 (0.86d±0.005) followed by T1 (0.75c±0.005) and T3 (0.65b±0.011) with the lowest (*p<0.05*) being observed fish fed diet control (0.59a±0.005). The better FCR significantly (*p<0.05*) was observed in fish diet T2 (3.18a±0.024) followed by T1 (3.75b±0.031) and T3 (4.39c±0.086), with the lowest (p<0.05) being observed fish fed diet control (4.76c±0.049). All data were shown in Table 2.fig.1.

In the present study the fish mintpowders additional in the diets have significantly affected the growth performance of silver carpfingerlings. The improvement in the growth performance and feed efficiency in fish mint fed groups could be due to the ability of the bioactive compounds to stimulating the secretion of digestive enzymes, thus resulting in nutrient utilization and muscle growth. (**Lee *et al*. 2012**) reported that garlic extract in the diet of Starlet sturgeon exhibited better FCR and PER. Similarly, (**Kaleeswaran *et. al* 2011**) also reported that *L. catla* fed with dietary *Cynodon dactylon* leaf meal showed an increase in weight gain, SGR and better FCR than the control group. The existence of anti‐nutritional factors (ANFs) in fish diet beyond the tolerant limit could inhibit nutrient absorption and causes reduction in growth (**Francis *et al*. 2001**). In the current study, the treatments with the highest body weight gain in T2. The highest weight gain was observed in treatment T2 (49.2d±0.16g), followed by the T1 (40.7c±0.0g), T3 (34.8b±0.3g), and control (32.5a±0.0g). These results might be due to the fish mint contained bioactive compounds, such as flavonoids, glycosides, pyridine alkaloids, and essential oils (**Zhang *et al*. 2008**); these compounds may have stimulated growth performance (Asha et al. 2015; Ahmad et al. 2017). According to (**Wigraiboon *et al*. 2016**), the WG and ADG of Hybrid red tilapia (*O. mossambicus Linn*. × *O. niloticus Linn*.) can be improved though the use of essential oils from fish mint and they also observed a lower FCR level. This not only had the effect of improving growth performance in aquatic animals, but also in mammalian animals. Similarly, report by (**Yan *et al*. 2011**) which revealed that 1 g/kg of fish mint powder extract, as a dietary supplementation, increased the average daily gain (ADG) and average daily feed intake (ADFI) of finishing pigs [(Landrace × Yorkshire) × Duroc]. Moreover, different plant extracts have been reported to have effects on growth promotion in fish, such as that of (**Fallahpour *et al.* 2014**) which shown that a diet supplemented with marshmallow (*Althaea officinalis*) extract at the level of 0.25% for 60 days demonstrated a dramatic increase in WG and SGR, and the condition factor of common carp (*Cyprinus carpio*). Similar, results showed that a significant increase in WG and SGR, and a decreased FCR in common carp (*C. carpio*), which were affected by dietary supplementation with *Avena sativa* extract, when compared to a control diet, with no herbal extract added (**Baba *et al.* 2016**). Different plant extracts effecting fish growth were reported, such as in the study by (**Gabriel *et al*. 2015**) they revealed that dietary *Aloe vera* supplementation at the levels of 0.5, 1.0, and 2.0%/ kg of feed improved WG significantly. Absolute growth rate and SGR, meanwhile, at 4%/kg feed increased the feed efficiency ratio, FCR, and hepatosomatic index in tilapia (GIFT). Moreover, they showed that the molecules of polysaccharides, acemannan, contained in A. *Aloe vera* have a prebiotic property. All of above things mentioned are accorded to researchers who have considered that unknown factors in various medicinal herbs have led to favourable results affecting fish growth, but they have concluded that the flavonoids and other bioactive compounds and constituents in plants can promote growth performance in fish (**Kim *et al.* 1998**). On the other hand, diets supplemented with *Moringa oleifera* extracts show significantly decreased feed intake and some growth dices in Nile tilapia, compared to control diets (**Dongmeza *et al.* 2006**) and similar results were found by (**Afuang *et al*. (2003)** with *M. oleifera* extract at the level of 102/kg of feed supplementation, which affected at by up to 17.5% in decreasing WG when compared with the control group.

**Conclusion**

In conclusion, inclusion of fish mint leaves to silver carp feed significantly impacted growth performance. Among the experiment inclusion levels (0%,3%,6%,9%), the diet containing 6% fish mint leaves (T2) yielded the best growth outcome, as indicated by higher weight gain, percent weight gain, length gain, feed conversion ratio (FCR) and specific growth rate (SGR) compare to other three treatments. These results suggest that moderate inclusion of fish mint leaves in silver carp (*H. molitrix*) diets enhances growth without compromising survival rates, which remained consistently high across all dietary groups. These Outcomes are supported by various studies emphasizing the ability to adapt and efficient feed utilization of silver carp when exposed to various dietary ingredients. Further research could explore optimal inclusion rates and long-term effects on health and productivity in silver carp (*H. molitrix*) aquaculture.

**Availability of data and Materials**

The data will be provided upon request to the journal.

**Ethical Statement:**

In the present study, silver carp were collected from the School of School, Sanjeev Agrawal Global Educational (SAGE) University, and Bhopal India). Ethical approval, specimen collection, and maintenance were performed in strict agreement with all the recommendations India.

**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 the writing or editing of this manuscript.

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**Table 2: Overall Growth parameters of different treatments**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Treatment | NWG | PWG | LG | SGR | FCR |
| C | 32.5a±0.000 | 38.7ab±1.154 | 16.9a±1.154 | 0.59a±0.005 | 4.76c±0.049 |
| T1 | 40.7c±0.000 | 42.3b±1.154 | 17.47a±1.154 | 0.75c±0.005 | 3.75b±0.031 |
| T2 | 49.2d±0.166 | 52.8c±1.301 | 17.8a±1.154 | 0.86d±0.005 | 3.18a±0.024 |
| T3 | 34.8b±0.333 | 36.4a±0.881 | 16.5a±1.154 | 0.65b±0.011 | 4.39c±0.086 |

 **Table 3: Overall Water Quality Parameter**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment** | **Temperature** | **pH** | **Dissolved Oxygen** | **Alkalinity** |
| **C** | 24 | 8.2 | 6.6 | 120 |
| **T1** | 24.3 | 8.0 | 5.3 | 150 |
| **T2** | 25.0 | 8.2 | 6.5 | 130 |
| **T3** | 24.7 | 8.4 | 6.0 | 124 |
| **T4** | 25.3 | 8.5 | 5.8 | 130 |

**Fig. 1 Growth Parameters of different Treatments**