Evaluating the Efficacy of *Houttuynia cordata* Leaf Meal in Enhancing Growth in Silver Carp (*Hypophthalmichthys molitrix*) Fingerlings

**Abstract**

To evaluate the effects of *Houttuynia cordata* (fish mint) leaf meal on the growth performance of *H. molitrix* fingerlings, a 45-day feeding trial was carried out. Four experimental diets containing 0%, 3%, 6%, and 9% *H. cordata* leaf meal were formulated, representing three treatment groups and one control. Each treatment was replicated three times. Growth performance indicators, including net weight gain, percent weight gain, Length gain, specific growth rate (SGR), feed conversion ratio (FCR), were evaluated. Findings revealed that incorporating fish mint leaves in the diet had a posstive impact on growth performance. Silver carp fed with 6 % treatment T3 fish mint leaves exhibited the highest average weight gain (49.2±0.166g), percent weight gain (52.8±1.301g), length gain (17.8±1.154) and specific growth rate (0.86±0.005), with improved feed conversion ratio (3.18±0.024). Interestingly, growth performance declined when fish mint leaves were included at 3% and 9% in the diet, implying that higher concentrations might have adverse effects.These results suggest that 6% inclusion of H. cordata leaf meal can enhance growth performance in silver carp fingerlings.

 **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 Involved in fishing-related activities. 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 17.55 MMT, with marine fish production of 4.32 MMT and inland fish production of 13.13 MMT**.** Andhra Pradesh has always been the topmost production state of fish in India, followed by West Bengal, the second. 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 (*Houttuynia cordata*) was a medicinal plant represent the family Saururaceae, which is found in mountainous regions of Eastern Asia and also found across Bhutan, China, Indonesia, Japan, Korea, Myanmar, Nepal, Thailand, Taiwan, Vietnam, and both the North-West Himalayan and North-East regions of India. This important medicinal plant is known by various traditional names like fish mint, fish wort, chameleon, lizard's tail, and fishy smell plant (**Tutupalli & Chaubal, 1974**). This herb traditionally used in folk medicine, fish mint shows range of therapeutic properties, including antiviral, antibacterial, immunostimulant, diuretic, anti-cancer, and anti-inflammatory effects was observed by **Kumar *et al.,* 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 experiments open the door feeding industry so that the fish mint leaf meal and extract in the diet act as a growth promoter. The experimental diet containing the herb fish mint fed to *L. vannamei* shrimp and fish (cobia) improved the growth and delayed the onset of any disease observed that giving fish mint in carp feed and concluded higher intestinal suitable bacteria and thus eliminating the disease‐causing non‐prominent bacteria from the intestine **Kumar *et al.,* 2014**.

 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 properly with the help of tap water to remove debris and air dried under shade. After complete drying, the fish mint leaf was powdered using a warring blender. A plastic container was use for storing the leaves powder for further use and remaining ingredients used in the feed making (rice bran, mustard oil cake (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 % crude protein and 5 % 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) were mixed together at the ratio; 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 % protein content that is 3, 6 and 9 percent of fish mint leaves added. After thorough mixing, the dough for each treatment was autoclaved for 30 minutes to eliminate microorganisms. A vitamin premix was then incorporated into the sterilized dough. This mixture was subsequently fed into a pelletizer and extruded to the appropriate size for fingerling fish. The resulting pellets were dried at 40°C for four hours to remove moisture.

The control feed contained 0% fish mint leaves. For the three experimental tanks, three distinct percentages of fish mint were used to formulate the diets. The ingredients for the control diet included fish meal, wheat flour, mustard oil cake (MOC), and rice bran.

**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** | 93.98 | 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** | 375g | 375g | 375g | 375g |

**2.5 Experimental Set-up**

The present study was employed for 45-day in 12 tanks: a single control group and three treatment groups, each replicated three times. The control diet contained no fish mint leaves (0%). Experimental treatments were represented as T1, T2, and T3 incorporated 3%, 6%, and 9% fish mint leaves, respectively. Feeding was done semi-daily, at 9:00 AM and 5:00 PM, with the feed quantities was calculated at 3% of the total fish biomass.

The tanks were water holding capacity was 200 L of water. Before the adding the fingerlings, tanks were properly disinfected with KMnO4 and NaCl solution. A water pump served as the water source for entire experimental period. After filling all 12 tanks with water then five fingerlings of sliver carp were introduced into each, following initial parameters of their net weight and total length. Ensure the continuous aeration in all tanks to optimal dissolved oxygen levels to mitigate fish stress and water quality parameters like temperature, pH, dissolved oxygen, and alkalinity were conducted 15 days, coinciding with fish weight measurements.

**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 data obtained from this study were analysed using the SPSS software version 16.00 . To the mean duncan value 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 and weight gain measured in all treatments during the study. By adding fish mint powder at different amounts and feeding it at 3% of the body weight, the study recorded continuous weight gain across all treatments. All growth parameters was (LG, NWG, PWG, SGR, FCR) analysed by weighing the silver carp at regular 15-day intervals.

The growth parameters of current study were recorded after 15 days. 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. **Liu *et al.* (2022)** they investigated the effects of *Houttuynia cordata* and *Artemisia argyi* extracts on growth, antioxidant response, lipid metabolism, and gut bacteria in grass carp (*Ctenopharyngodon idella*). (**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**). Here are a few options to rephrase the text, focusing on clarity and avoiding plagiarism:

Option 1 (Streamlined)

In the current study, Treatment 2 (T2) exhibited the most significant body weight gain, reaching 49.2 ± 0.16g. This was followed by T1 (40.7 ± 0.0g), T3 (34.8 ± 0.3g), and the control group (32.5 ± 0.0g). These findings may be attributed to the bioactive compounds present in fish mint, such as flavonoids, glycosides, pyridine alkaloids, and essential oils (Zhang et al., 2008), which have been reported to stimulate growth performance (Asha et al., 2015; Ahmad et al., 2017).

Research by Wigraiboon et al. (2016) demonstrated that essential oils from fish mint can enhance the weight gain (WG) and average daily gain (ADG), alongside reducing the feed conversion ratio (FCR), in Hybrid red tilapia (O. mossambicus Linn. × O. niloticus Linn.). The growth-promoting effects of fish mint are not limited to aquatic species; Yan et al. (2011) observed that a dietary supplement of 1 g/kg fish mint powder extract increased the ADG and average daily feed intake (ADFI) in finishing pigs [(Landrace × Yorkshire) × Duroc].

Furthermore, various plant extracts have shown promise in promoting fish growth. For instance, Fallahpour et al. (2014) found that supplementing the diet of common carp (Cyprinus carpio) with 0.25% marshmallow (Althaea officinalis) extract for 60 days significantly increased WG and specific growth rate (SGR), as well as improving the condition factor. Similarly, increased WG and SGR, coupled with a decreased FCR, were noted in common carp fed diets supplemented with Avena sativa extract compared to control diets without herbal extracts. Gabriel et al. (2015) also reported significant improvements in WG in fish when dietary Aloe vera was supplemented at levels of 0.5, 1.0, and 2.0%/kg of feed.

The present investigation revealed that treatment T2 resulted in the highest body weight gain (49.2 ± 0.16g), surpassing T1 (40.7 ± 0.0g), T3 (34.8 ± 0.3g), and the control (32.5 ± 0.0g). This outcome likely stems from the bioactive components within fish mint, including flavonoids, glycosides, pyridine alkaloids, and essential oils (**Zhang *et al.,* 2008**), which are recognized for their potential to enhance growth (**Asha *et al.,* 2015; Ahmad *et al.,* 2017**). Supporting this, **Wigraiboon *et al.* (2016)** reported that essential oils from fish mint improved the weight gain (WG) and average daily gain (ADG) while simultaneously lowering the feed conversion ratio (FCR) in Hybrid red tilapia (*O. mossambicus Linn.* × *O. niloticus Linn*.). The efficacy of fish mint extends beyond aquaculture, as demonstrated by **Yan *et al.* (2011),** who showed that supplementing the diet of finishing pigs [(Landrace × Yorkshire) × Duroc] with 1 g/kg of fish mint powder extract led to increased ADG and average daily feed intake (ADFI).

Further evidence for plant extract-mediated growth promotion in fish comes from other studies. Fallahpour et al. (2014) observed a substantial increase in WG, specific growth rate (SGR), and condition factor in common carp (*Cyprinus carpio*) when their diet was supplemented with 0.25% marshmallow (*Althaea officinalis*) extract over 60 days. Analogous improvements in WG and SGR, alongside a reduced FCR, were noted in common carp receiving dietary Avena sativa extract compared to a control diet lacking herbal additions. Additionally, **Gabriel *et al.* (2015**) documented significant enhancements in WG in fish with dietary *Aloe vera* supplementation at concentrations of 0.5, 1.0, and 2.0%/kg of feed.

 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 **Ha & Thuy (2025)** they examined the dietary effects of *H. cordata* and *Perilla frutescens* leaf powders on growth, gut microflora, and meat quality in chickens have considered that unknown factors in various medicinal herbs have led to favourable results affecting fish growth, but 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 10.2/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:Average Water Quality Parameter**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment** | **Temperature** | **pH** | **Dissolved Oxygen** | **Alkalinity** |
| **C** | 24±0.00 | 8.2±0.34 | 6.6±0.01 | 120±1.14 |
| **T1** | 24.3±1.84 | 8.0±0.23 | 5.3±0.08 | 150±0.000 |
| **T2** | 25.0±1.54 | 8.2±0.000 | 6.5±0.01 | 130±1.43 |
| **T3** | 24.7±0.00 | 8.4±0.65 | 6.0±0.04 | 124±1.23 |
| **T4** | 25.3±0.15 | 8.5±0.000 | 5.8±0.03 | 130±0.000 |

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