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A study to investigate the growth performance of fingerlings of common carp *Catla catla* fed a diet containing sorghum and pearl millet

Govind Nikam and Ivan AranhaDOI: <https://www.doi.org/10.33545/26649926.2025.v7.i6a.356>**Abstract**

The nutritional effects of a mixed feed consisting of pearl millet (*Pennisetum glaucum*) and great millet sorghum (*Sorghum bicolor*) on the growth performance of *Catla catla* fingerlings were examined in this study. During the 60-day trial, experimental diets were created by replacing an equivalent amount of rice bran with flour from sorghum and pearl millet. A total of 15 glass tanks, each with a 75-liter capacity, were randomly assigned to 375 healthy *Catla catla* fingerlings, weighing an average of 16.52 ± 0.01 g. These tanks were split into five treatments, each with three duplicates, including a control group. Throughout the 60 days, the fingerlings were fed 1% of their body weight twice daily, in the morning and the evening. In contrast to the control group, which was fed only rice bran, the experimental diets included sorghum and pearl millet in a 1:1 ratio at different inclusion levels (5%, 10%, 15%, and 20%). Weekly measurements were made of water quality parameters, including pH, dissolved oxygen (DO), electrical conductivity (EC), total alkalinity, hardness, nitrate, orthophosphate, and air and water temperature. The experimental fish fingerlings fed a diet consisting of sorghum and pearl millet showed better growth performance, according to the results. The group with a 15% inclusion rate (G3) saw the most weight gain of 41.200 ± 0.145 g, whereas the control group (G0) that did not receive sorghum and pearl millet experienced the lowest weight gain of 32.428 ± 0.029 g. Additionally, G3 had the lowest feed conversion ratio (FCR) at 3.158 ± 0.012 , whereas the control group had the highest at 3.876 ± 0.078 . The control group (G0) had the lowest specific growth rate (SGR) at $1.512 \pm 0.002\%$, whereas G3 had the highest at $1.985 \pm 0.003\%$. Results show that *Catla catla* fingerlings fed a 1:1 ratio of sorghum millet to pearl millet preserves the water quality and promotes healthy development.

Keywords: Catla, fingerlings growth, growth performance, pearl millet, sorghum**Introduction**

India's freshwater aquaculture relies heavily on common carp (*Cyprinus carpio*), which makes a large contribution to the country's fish output. Because of its flexibility and compatibility with native species, common carp, which was introduced in the late 1950s together with other alien species including silver carp and grass carp, has proven essential to polyculture systems ^[1]. In India, common carp are frequently combined with native species including mrigal (*Cirrhinus cirrhosus*), rohu (*Labeo rohita*), and catla (*Catla catla*) in polyculture methods. By maximizing the use of various ecological niches within ponds, this method raises total output. For example, mrigal and common carp live in the bottom layers of the water, where they feed on detritus and benthic animals; rohu and grass carp use the intermediate strata, where they consume aquatic vegetation; and catla and silver carp live in the top strata, where they graze on plankton ^[2].

The output of common carp has been considerably increased by the introduction of better varieties. Notably, in 2010, Meghalaya saw the introduction of the Amur (Hungarian) breed of common carp. This strain reached maturity in around 14 months at mid-altitude, according to studies, and showed better growth performance than current local breeds ^[3]. Despite these developments, native species like catla and rohu, which fetch higher prices, are more popular in the Indian market than common carp. As a result, many farmers place a high priority on cultivating these indigenous plants.

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Common carp are now a crucial part of freshwater aquaculture in India, especially in polyculture systems. Its incorporation improves the use of resources and raises aquaculture operations' general productivity.

India has several challenges when it comes to carp farming, especially when it comes to the price and accessibility of high-quality fish feed. A significant amount of carp farming's operating expenditures is related to feed. According to research that was published in the Indian Journal of Fisheries, the most sensitive element influencing the carp culture's economic viability was feed cost. Changes of $\pm 10\%$, $\pm 20\%$, and $\pm 30\%$ in feed costs led to variations in net present value (NPV) and internal rate of return (IRR) of 7% to 20% and 5% to 15%, respectively [4].

Indian carp farmers have historically depended on farm-made feeds, which are mostly made up of oil cakes and de-oiled rice bran (DORB). Carp in polyculture systems are frequently given oil cake, DORB, or a blend of the two, usually at a cake-to-bran ratio of 10:90. Carp juveniles are first fed only DORB until they weigh 350 g, at which point they are given a combination of DORB and oil cake. Despite their affordability, these feeds frequently have unbalanced nutrition, which results in less-than-ideal growth rates and elevated feed conversion ratios (FCRs) [5].

Better nutritional profiles and increased water stability are provided by commercial pelleted feeds, particularly floating pellets. However, because they are more expensive and not always available, their use is restricted. For example, farm-made mash feeds cost about US\$0.27 per kg, but floating pellets might cost up to US\$0.50 per kg. Furthermore, feed producers frequently demand minimum orders of about 10 tons, which presents logistical difficulties for small-scale farms [6]. Combining commercial feeds with conventional farm-made feeds has shown promise as a solution to these issues. Research carried out in Andhra Pradesh's West Godavari area showed that using commercial sinking feeds in conjunction with de-oiled rice bran enhanced FCRs and decreased production costs. An FCR of 2.3 and a feed cost of Rs. 64.4 per kilogram of fish were attained using the ideal mix of 50% DORB and 50% commercial sinking feed [7].

One of the biggest obstacles to Indian carp farming is the high price and scarcity of good-quality fish food. Feed efficiency and financial returns for farmers can be increased by employing techniques like blending conventional and commercial feeds and improving feed compositions. Therefore, the current study examines the growth performance of common carp fingerlings (*Catla catla*) fed a diet that includes pearl millet and sorghum. This study aims to investigate the dietary effects of a mixed feed containing great millet sorghum (*Sorghum bicolor*) and pearl millet (*Pennisetum glaucum*) on the growth of *C. catla* fingerlings.

Materials and Methods

Experimental setup and design

Fifteen glass tanks, each with a 75-liter capacity, were randomly assigned to 375 healthy *Catla* fingerlings, weighing an average of 16.52 ± 0.01 g. The experimental tanks' specifications are as follows: Volume: 75 liters; Dimensions (LxWxH): 60.9 x 32.2 x 40.6 cm; Filter Type: 5.5W Hang-on Filter; Filter Flowrate: 450 L/H; Lighting Type: 9.6W White Energy Saving LED. These tanks were split up into five treatments, each with three duplicates, including a control group.

The Test

The fingerlings utilized in the experiment were fed 30% protein diet before stocking after being acclimated for 15 days. There were four treatment groups in the trial, each in triplicate, along with a control group.

The experimental feed was composed of soybean meal, sunflower oil, and a vitamin-mineral combination known as Rigmin-Aqua, and it had 30% protein and a 1:1 ratio of sorghum to pearl millet. The fingerlings were fed 1% of their body weight twice a day, in the morning and the evening, for the duration of the 60 days. The experimental diets contained sorghum and pearl millet in a 1:1 ratio at varying inclusion levels (5%, 10%, 15%, and 20%) as opposed to the control group, which was administered feed comprised of rice bran. Weekly measurements were made of water quality parameters, including pH, dissolved oxygen (DO), electrical conductivity (EC), total alkalinity, hardness, nitrate, orthophosphate, and air and water temperature.

Preparation of control diet

A control diet was prepared by mixing groundnut oil cake, rice bran, wheat flour, soya bean meal, sunflower oil, and vitamin-mineral mixture in a ratio of 40:30:14:10:3:2 following earlier publications [8].

Preparation of the experimental diet

The control diet's equal parts of rice bran and wheat flour were changed out for a 1:1 mixture of sorghum and pearl millet flour to create the experimental diet. Treatments G1 (5%), G2 (10%), G3 (15%), and G4 (20%) used four different amounts of sorghum and pearl millet flour in their diets. All of the components for the fingerlings' diet, including grains, were purchased fresh from the local market. After mechanically grinding the sorghum, pearl millet was sieved through a sieve with pores that were 100 μ m in diameter. After that, it was stored in a container and maintained at room temperature until it was used. To make a dough, a soybean meal, a vitamin and mineral mixture, and the appropriate quantity of dry materials from the diet were combined. The ingredients were autoclaved in powder form for 30 minutes at 150 pounds of pressure before creating dough. Following cooling and dough preparation, the paste was extruded through vermicelli a hand pelletizer machine. After that, it was crushed into pellets, allowed to air dry in the shade, and stored in airtight containers for later use.

Determination of fish growth parameters and survival

Fifteen fish ($n = 15$) were sampled weekly from each treatment without being sacrificed to assess the growth performance of the fish involved in the experiment. The following formula was used to calculate the growth metrics, including weight gain %, feed conversion ratio (FCR), specific growth rate % (SGR), and survival %:

Survival rate (%) = $100 \times (\text{Final fish count} / \text{Initial fish count})$

Weight gain (%) = $(\text{Final Weight} - \text{Initial weight}) \times 100 / \text{Initial Weight}$

FCR = Dry weight of feed given / body weight gain

SGR (%) = $(\text{Natural log Final Weight} - \text{Natural log Initial Weight} / \text{No. of Expt. Days}) \times 100$

Statistical Analysis

The Statistical Package for Social Sciences (SPSS, version 16.0 for Windows) was used for all statistical analyses. To ascertain the variations among the mean values, analysis of variance (one way, or ANOVA) was conducted. Duncan's Multiple Range Tests (DMRT) were used to test for differences at the $P < 0.05$ level.

Results

Water quality parameters

Throughout the trial, weekly measurements of the water's physicochemical characteristics were made and are shown in Table 1. Weekly measurements were made of water quality parameters, including pH, dissolved oxygen (DO), electrical conductivity (EC), total alkalinity, hardness, and air and water temperature. Average water temperatures for the experiment were around 27.6 °C, 6.66 pH, 7.47 mg/l dissolved O₂, 161.2 µS/cm electrical conductivity, 137.6 mg/l total alkalinity, and 386.2 mg/l total hardness.

Table 1: Ranges of water quality parameters during the experimental period.

Parameters	Control	Group 1	Group 2	Group 3	Group 4
Air Temperature (°C)	28.8 ± 0.85				
Water Temp (°C)	27.5 ± 0.87	27.6 ± 0.75	27.8 ± 0.86	27.4 ± 0.88	27.7 ± 0.84
pH	6.65 ± 0.06	6.63 ± 0.05	6.72 ± 0.04	6.56 ± 0.06	6.78 ± 0.04
Dissolved O ₂ (mg/l)	7.85 ± 0.02	7.52 ± 0.04	7.25 ± 0.23	7.65 ± 0.02	7.12 ± 0.01
Elect. conduct (µS/cm)	161.5 ± 1.63	162.52 ± 20.60	160.4 ± 21.58	161.3 ± 20.60	162.7 ± 21.61
Total Alkalinity (mg/l)	138.5 ± 1.54	138.2 ± 1.50	135.8 ± 1.49	139.4 ± 1.55	138.7 ± 1.54
Total Hardness (mg/l)	386.219 ± 2.15	385.29 ± 2.15	390.19 ± 2.15	384.129 ± 2.15	386.29 ± 2.15

Values are mean ± standard error.

The experimental fish fingerlings fed a diet consisting of sorghum and pearl millet. The main components of sorghum and pearl millet are around 60-70% Carbohydrates and 10-12% proteins. To improve the protein component Fish feed prepared from sorghum and pearl millet, which have moderate protein contents (~10-12%), was supplemented with high-protein components, such as soybean meal (crude protein 44-48%), to improve its protein composition. The experimental fish fingerlings fed a diet consisting of sorghum and pearl millet showed better growth

performance, according to the results as shown in Table 2. The group with a 15% inclusion rate (G3) saw the most weight gain (41.200±0.145g), whereas the control group (G₀) that did not receive sorghum and pearl millet experienced the lowest weight gain (32.428±0.029g). Additionally, G3 had the lowest feed conversion ratio (FCR) at 3.158±0.012, whereas the control group had the highest at 3.876±0.078. The control group (G₀) had the lowest specific growth rate (SGR) at 1.512±0.002%, whereas G3 had the highest at 1.985±0.003%.

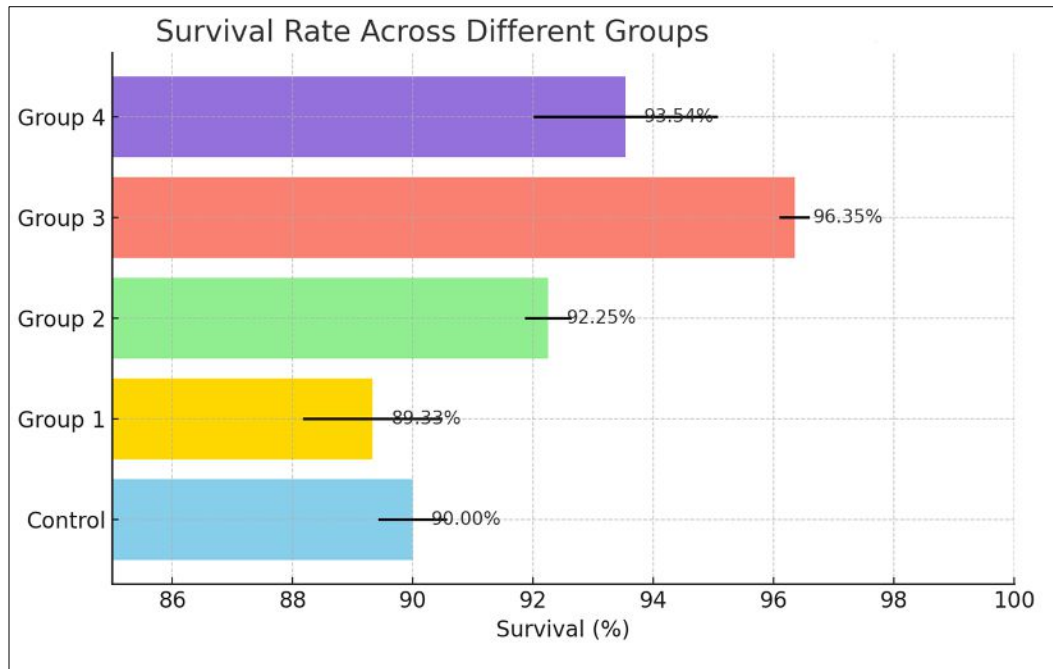


Fig 1: Shows a bar graph with error bars showing the standard deviation of the survival rates (%) of *C. catla* fingerlings across different groups.

Table 2: Initial mean weight, final mean weight (g) ± S.E. of treatment groups for 60 days of Catla fingerling culture.

Culture period	Control (G ₀)	Group 1 (G ₁)	Group 2 (G ₂)	Group 3 (G ₃)	Group 4 (G ₄)
Initial	16.52 ± 0.08 ^a	16.12 ± 0.04 ^a	15.82 ± 0.05 ^a	15.78 ± 0.08 ^a	15.89 ± 0.06 ^a
Final	32.428 ± 0.29 ^b	35.824 ± 0.22 ^b	38.128 ± 0.13 ^b	41.200 ± 0.45 ^b	38.828 ± 0.79 ^b
FCR	3.876 ± 0.78 ^a	3.678 ± 0.087 ^b	3.778 ± 0.077 ^c	3.158 ± 0.012 ^d	3.776 ± 0.056 ^c
SGR in %	1.512 ± 0.02 ^a	1.622 ± 0.001 ^b	1.652 ± 0.004 ^b	1.985 ± 0.003 ^c	1.752 ± 0.001 ^d

Values are weights in grams mean $\pm$ standard error; FCR-Feed conversion ratio; SGR-Specific growth rate. Values within the same column are denoted by various superscript letters, and values between columns with different superscripts are significantly different ($P < .05$). The data are shown as mean $\pm$ SE. The Duncan test ($P < .05$) and two- and one-way ANOVA were performed on the data.

Catla fingerlings reared with experimental feed formulation show better growth performance and survival than the control. The survival percentage across the group is shown in Figure 1. There is a significant ($P > .05$) increase in final weight across the groups as shown in Table 2. SGR, and weight gain (%) across all the groups compared to the initial period are significantly high. FCR is found significantly ($P < .01$) lower in treatment groups compared to the control group. Among the treatments, the best FCR is found in the group three. The survival percentage was noticed daily by visual inspection and the best survival at the end of the experiment was noted in group three followed by groups two and four.

Discussion

One of the most crucial needs for fish aquaculture is water. Aquaculture depends on both the amount and quality of water [9-10]. Fish production is largely reliant on the physical, chemical, and biological characteristics of the water. Consequently, knowledge of water quality is necessary for effective pond management. Temperature, clarity, turbidity, color, carbon dioxide, pH, alkalinity, hardness, unionized ammonia, nitrite, nitrate, primary productivity, BOD, plankton population, and other factors all affect the quality of water. Fish species eliminate oxygen and particulate organic matter (plankton and bacterioplankton) from the environment while releasing a variety of waste products, including ammonium, carbon dioxide, and organic matter that contains nutrients. The physical and chemical state of the tank's water will be impacted by feeding¹⁰. Both directly and indirectly, feed will contaminate the water. Fish waste and leftover feed contributed organic matter to the water, which decomposed and released ammonia and oxygen. Poor water quality and lack of sufficient water supply pose the greatest threat to fish production. As recommended by Bhatnagar and Devi (2013) [11], the experiment's range of water quality metrics, including pH and temperature, was determined to be within ideal bounds. Treatment groups performed noticeably better than controls in terms of growth performance. Overall, the results indicate that feeding *Catla catla* fingerlings a diet consisting of a 1:1 ratio of sorghum millet to pearl millet helps to preserve the quality of the water and encourage healthy growth.

Despite being considered a major grain worldwide, millets are the least used of all the grains, according to Hassan *et al.*, [12]. Because millet grain is high in nutrients and phenolic compounds that are beneficial to health, it is perfect for use as food and feed. Finger and pearl millet's variety of minerals and phenolic compounds are clear signs that selecting millet for use as food or feed needs careful thought. Millets include phenolic features, such as flavonoids, tannins, and phenolic acids, all of which are beneficial to human health [13]. Furthermore, the phenolic profile of finger millet differs from that of pearl millet in a major way and is richer and more diversified. Research has shown that the phenolic components of millet have a substantial antioxidant action. Both human and animal

health benefit from the phytochemicals included in millet grains [12-15].

Millets have strong antioxidant activity because of their phenolic qualities. Millet grains' phytochemical content improves human health by reducing the body's levels of phytates and cholesterol. The hunt for substitute grains is justified due to the overwhelming demands placed on maize and its numerous applications in various sectors. When maize was replaced with finger and pearl millet in the diets of several animals, the animals' performance improved. In the present investigation, similar results were obtained. Consuming these grains might reduce the risk of illness and promote better health. It is possible to incorporate at least 50% pearl millet into broiler diets without hurting egg production or broiler performance. Recently, millet grain has been utilized to prepare traditional drinks and added to other dishes [12, 16].

There are not enough resources to feed everyone with wholesome food in the current situation due to shifting eating preferences, population growth, and unchecked exploitation of natural resources. Since natural plant resources are rapidly running out, other options must be investigated. Other underused crops have the potential to replace the staple crops wheat and rice. One of these significant underused crops with Nutri-cereal potential is millet. Millets have dietary qualities, are gluten-free, non-acid-forming, and are very nutritious. Due to a lack of knowledge about their nutritional benefits, millets are still only consumed by the traditional and impoverished, despite their high nutritional content. Millets are becoming more outdated because of a lack of processing technology, a lack of food subsidies, and difficulties with meal preparation. Rich in carbohydrates, dietary fiber, energy, essential fatty acids, proteins, vitamin B, and minerals like calcium, iron, magnesium, potassium, and zinc, millets are nutri-cereals that help prevent post-translational diseases like diabetes, cancer, cardiovascular, and celiac diseases, among others. Despite its beneficial effects on blood pressure, blood sugar, and thyroid function, millet is nevertheless becoming less and less popular [17-20].

Conclusion

Feed accounts for about 80% of aquaculture's production input costs. Therefore, lowering feed costs by employing less expensive feed ingredients without compromising fish development is essential to achieve the definitive goal of high profits from carp production. The quality of the feed may be raised by employing different ingredients like pearl millet and sorghum are possible substitutes. Despite their importance, millets are the least exploited grain in the world. Millets are the main crops in the semi-arid tropical regions of Asia and Africa, particularly in India, where they are produced in over 97%. Different animals performed better when their diets were replaced with pearl millet and great millet instead of maize. Incorporating these grains into the diet may improve health and reduce disease risks. It can increase aquaculture production yields by improving feed digestibility. Sorghum and pearl millet have the potential to be used as supplemental feed for *Catla catla*, however further research is needed.

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