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Impact of Azolla-Based Vermicompost on Water Quality Parameters and Growth Performance of Amur Carp (*Cyprinus carpio var. haematopterus*) in Sodic Soil Ponds

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present work was designed to evaluate the efficacy of Azolla-based vermicompost on the water quality and Amur carp growth potential sodic soil condition. A 90 days experiment was conducted in FRP tanks measuring containing Sodic soil bed to simulate pond conditions. Three experimental groups, each with duplicate tanks, were established. In each tank, 10 *Cyprinus carpio var. haematopterus* fry (with an average weight of (1.23 ± 0.03g) were stocked. Using a Completely Randomised Design (CRD), three different fertilization treatments were administered: T1 with Cow dung (CD) @ 15 t/ha/yr, T2 with manure containing cow dung-based vermicompost (CDV) at the same rate, and T3 with manure containing Azolla-based vermicompost (ABV), also @ 15 t/ha/yr. Throughout the experiment, the fish were fed an artificial diet @ 5% of total body weight while also consuming natural food (plankton) available in the tanks. Water quality parameters were found to be within the optimum range for Amur carp culture in all the treatments. Fish growth in terms of total weight gain, total length gain, percentage weight gain and specific growth rate was recorded maximum in treatment ABV followed by CDV and CD.

Keywords: Azolla; vermicompost; sodic soil; cyprinus carpio haematopterus; growth potential.

1. INTRODUCTION

India's underutilized agricultural land, including sodic, alkaline, and inland saline soil shaving good prospective for fish production, livelihood development, and economic prosperity (DoF, 2020). Soil is a fundamental natural resource that plays important roles in the environment, economy, and society. Sodic soil is often unsuitable for agriculture and aquaculture due to low productivity and high cost of production. However, after reclamation, it can be used in fish farming to increase soil productivity. For the soil reclamation various methods and substances are applied in sodic soil areas. In which organic manures improve soil health and productivity and also support to grow bacterial population which helps in the production of zooplankton (FAO, 1997) and are nutritious and preferred food items for many aquaculture species (Pillay, 1990). Various challenges are also related with organic manure like their huge quantity, water quality deterioration, low nutrients profile, and quantify slandered dose (Godara et al., 2015). Therefore, other option of traditional manure should be explored (Gajalakshmi et al. 2001).

In the category of organic manures vermicompost also applied in fish pond (Kaur and Ansal, 2010) for the enhancement of pond productivity and found that it contains a large amount of essential minerals, vitamins, enzymes, antibiotics, growth promoters, and other compounds (Mitra,1997, Bhusan and Yadav, 2003). Vermicomposting is a process of conversion of agricultural and organic waste to wealth in the form of excellent organic manure with the help of earthworms and also eco-friendly in nature (Reinecke and Alberts, 1987). Some studies have shown that this fertilizer contains a number of enzymes such as peroxidase, protease, amylase which are necessary to increase the effectiveness of Microbiology in the soil (Bottinelli et al. 2010; Abd and Abdullah, 2024; Tolera et al. 2024). The vermicompost is safest organic manure as others (raw cattle dung, poultry & piggery manure and other compost) because it is fully decomposed manure and can not deteriorate pond water quality after application in pond. The aquatic weeds are presents in all the natural and manmade water bodies with varied limnological characteristics, presenting high plasticity and adaptation ability. They maintain ecological balance and food chain (Najar, 2017). But when they are in excess in amount creates various types of problem for living organisms like cultured fishes by covering surface water, low light penetration, hindering in free swimming of fishes and fish harvesting. Therefore, its removal and safe utilization is very important and it can be done by making compost and vermicompost from these aquatic weed (Chauduri et al., 2001; Sannigrahi et al., 2002; Gajalakshmi et al., 2001; Sannigrahi, 2009). *Azolla sp.* is also one of them aquatic weed which found in various water bodies in abundant amount and many worked on Azolla based vermicompost was conducted and found that the vermicomposting could be an effective to convert the *Azolla sp*. (Gandhi and Sundari, 2012) into a value-added product vermicompost Najar and Khan (2010), Ghosh (2004).

Therefore, present study was focused on the use of Azolla for vermicomposting with cattle dung as organic manure to assess the efficacy of Azolla

based vermicompost for the water quality parameter and its impact on growth performance on Amur carp (*Cyprinus carpio haematopterus*) during study period because it can be a good candidate species for culture point of view in sodic soil conditioned pond.

2. MATERIALS AND METHODS

2.1 Experimental Site and Fish

The study was conducted in outdoor conditions in the College of Fisheries, ANDUA & T, Kumarganj, Ayodhya (U.P.), India. The Experimental fish (*Cyprinus carpio haematopterus*) fry was brought from the instructional fish farm of the College of Fisheries, GBPUAT Pantnagar, Uttarakhand and reared in the wet laboratory of the College of Fisheries, Kumarganj for further experiment. The ANDUAT, Kumarganj is a sodic soil-affected area, therefore, this study was designed in a sodic soil base area (Sannigrahi 2009).

2.2 Collection and Culture of *Azolla pinnata*

Azolla pinnata was brought from natural water bodies near ANDUA&T, Kumarganj, Ayodhya. Azolla culture was allowed to grow for 30 days under the shed house for production and manured with cattle dung with soil and Single Super Phosphate (SSP).

2.3 Vermicomposting

Two types of vermicompost were prepared, the first one was made up of only cow dung and the second one was from 50% semi-dried Azolla mixed with 50% cow dung. The *Eisenia foetida* earthworm species were selected for vermicomposting purposes. These two types of vermicompost were prepared separately in separate pits under shade conditions.

2.4 Experimental Design

The study period was designed for 90 days in FRP tanks measuring 0.93m x 0.61m x 0.63m, each tank containing a 6-inch layer of sodic soil bed to simulate pond conditions. Three experimental groups, each having duplicate tanks were established. Each tank was stocked with 10 *Cyprinus carpio haematopterus* fry (with an average weight of 1.23 ± 0.03g). Employing a Completely Randomised Design (CRD), three different fertilization treatments were administered: T1 manured with Cow dung (CD) @ 15 t/ha/yr, T2 manured with cow dung-based vermicompost (CDV) @ 15 t/ha/yr, and T3 manured with Azolla-based vermicompost, also @ 15 t/ha/yr. Throughout the experiment, the fish were fed an artificial diet @ 5% of total body weight and also consumed natural food (plankton) available in the tanks. The aim of the experiment was to assess the growth and performance of the *Cyprinus carpio haematopterus* fry under varying fertilizer treatments and water quality changes.

2.5 Sampling Schedule

Physico-chemical parameters of tank water were analysed at every seven-day interval basis as per the procedure of APHA (2005). In addition, fish growth parameters like length and weight were measured on at monthly basis.

2.6 Growth Parameters of Experimental Fishes

The length and weight of fish of each experimental group (CD, CDV, ABV) were recorded at 0, 15, 30, 45, 60, 75 and 90 days of experiment by using electronic balance and scale. Parameters of growth performance were analysed using standard formulas as follows-

- Total length gain = Final length gain – Initial length gain
- Total weight gain = Final weight gain – Initial weight gain
- Specific growth rate, SGR (%)= $\frac{\text{LogW2}-\text{LogW1}}{\text{T2}-\text{T1}} \times 100$

Where,

W1= the initial live body weight (g) at time T1 (day)
W2= the final live body weight (g) at time T2 (day)

- Percentage weight gain = $\frac{\text{Final weight of fish}-\text{Initial weight of fish}}{\text{Initial weight of fish}} \times 100$

3. RESULTS

3.1 Water Quality Parameters

The study was focused on to assess the impact of different organic manures cow dung (CD), cow

dung-based vermicompost (CDV), and Azolla-based vermicompost (ABV) on various water quality parameters in sodic soil conditioned. The water parameters such as temperature, dissolved oxygen, ph, alkalinity, hardness, free CO_2 and electrical conductivity were found in optimum range in all treatments. The declination in pH values were found in CD treatment from 8.89 to 8.81 followed by in CDV treatment from 8.89 to 8.60, and in ABV treatment from 8.88 to 8.20. The maximum declination in pH values were found in ABV treatment. While during the experimental period water temperature fluctuated from 11.9°C to 23.56°C across in all the treatments. The dissolved oxygen (DO) levels increased over time in CD treatment from 4.4 ± 0.2 mg l^{-1} to 7.0 ± 0.5 mg l^{-1}, followed by in CDV treatment from 4.4 ± 0.2 mg l^{-1} to 7.4 ± 0.5 mg l^{-1} and in ABV treatment it varied from 4.5 ± 0.4 mg l^{-1} to 7.6 ± 0.0 mg l^{-1} and maximum dissolved oxygen level was found in ABV treatment. Total hardness varied: CD increased from 234.0 mg L^{-1} to 237.0 mg L^{-1}, CDV decreased from 235.0 mg L^{-1} to 231.0 mg L^{-1}, and ABV decreased from 234.33 mg L^{-1} to 217.0 mg L^{-1}. In addition, alkalinity increased in CD and decreased in CDV and ABV, while free CO_2 levels were highest in CD. Electrical conductivity showed slight variations. It increased from 0.98 mS/cm to 1.07 mS/cm in CD, decreased from 0.97 mS/cm to 0.91 mS/cm in CDV, and increased from 0.96 mS/cm to 0.97 mS/cm in ABV. These findings highlight the Azolla-based vermicompost (ABV) potential to improve water quality indicators that are crucial for aquaculture techniques that are sustainable.

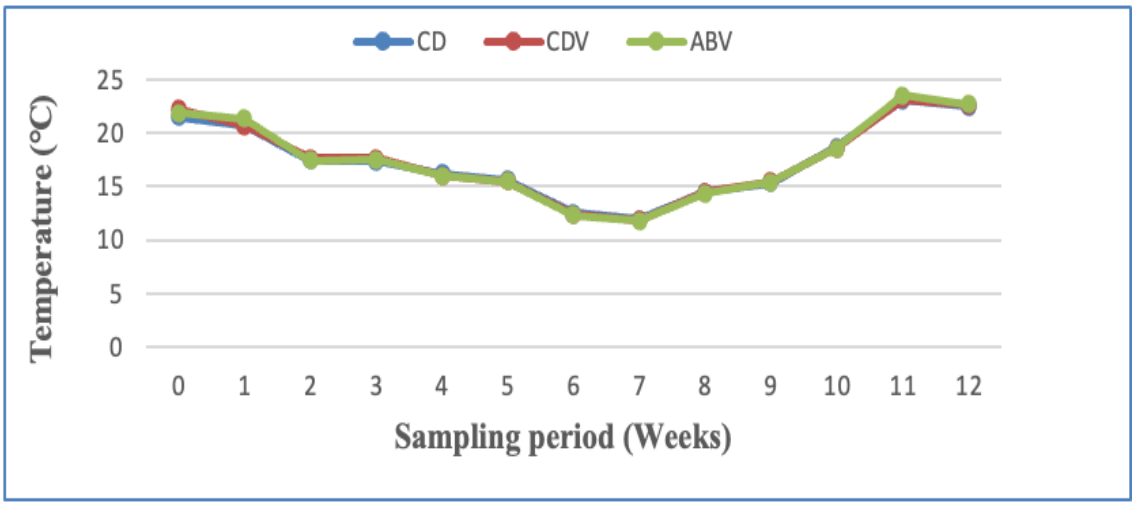

Fig. 1. Water temperature

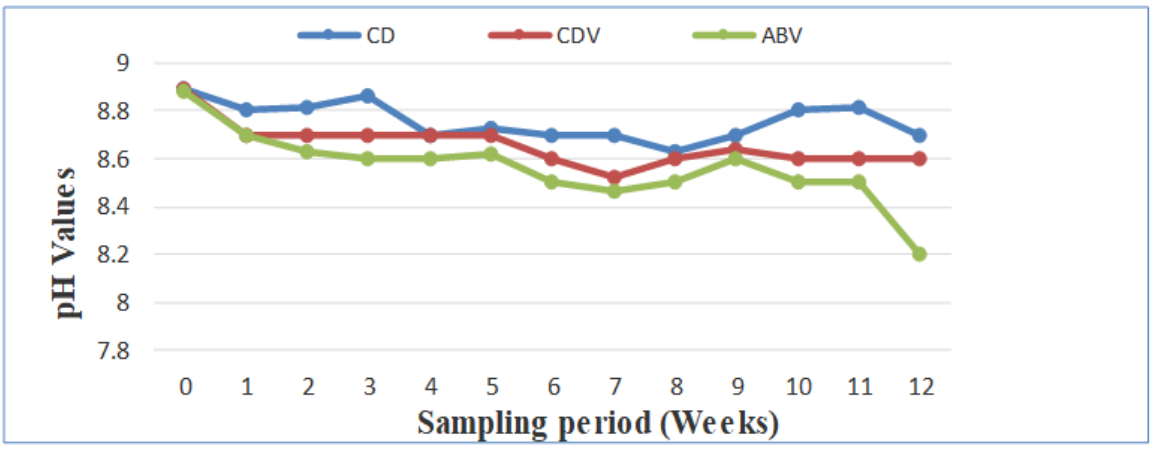

Fig. 2. Water pH

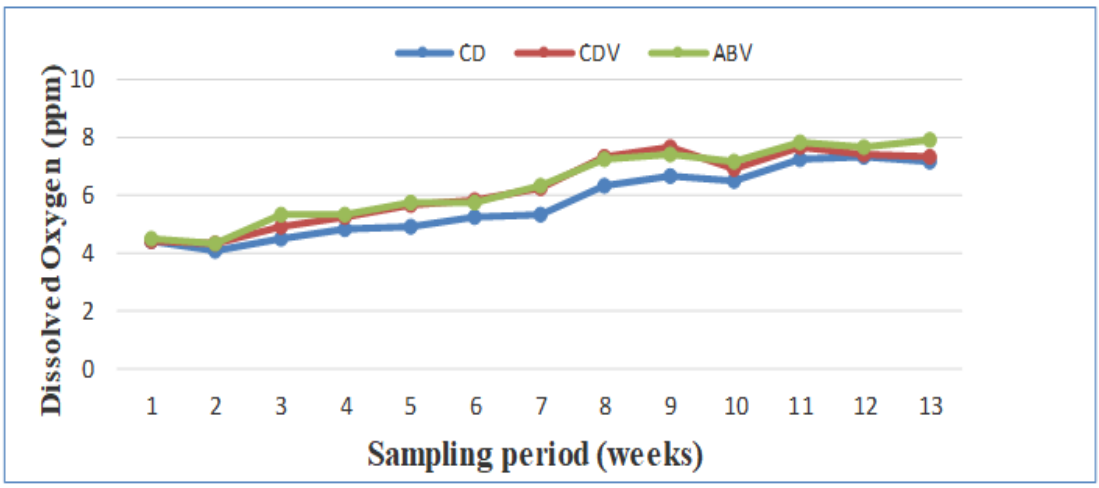

Fig. 3. Dissolved oxygen (ppm)

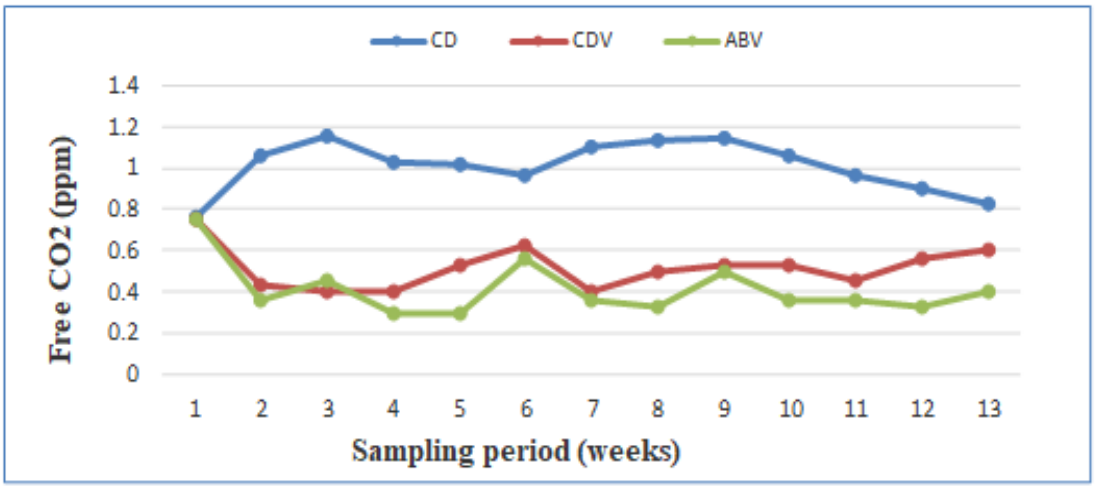

Fig. 4. Free CO_2 (ppm)

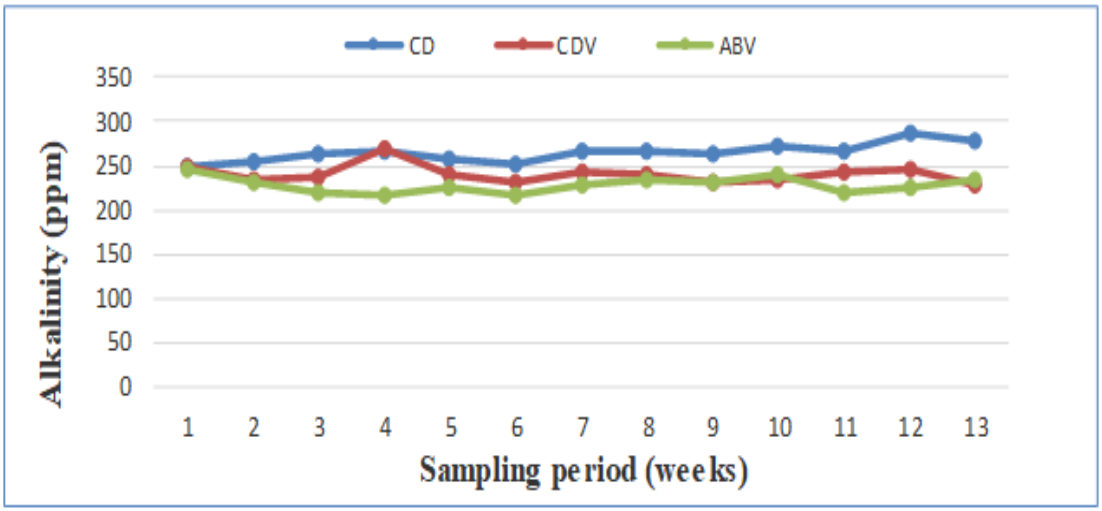

Fig. 5. Alkalinity (ppm)

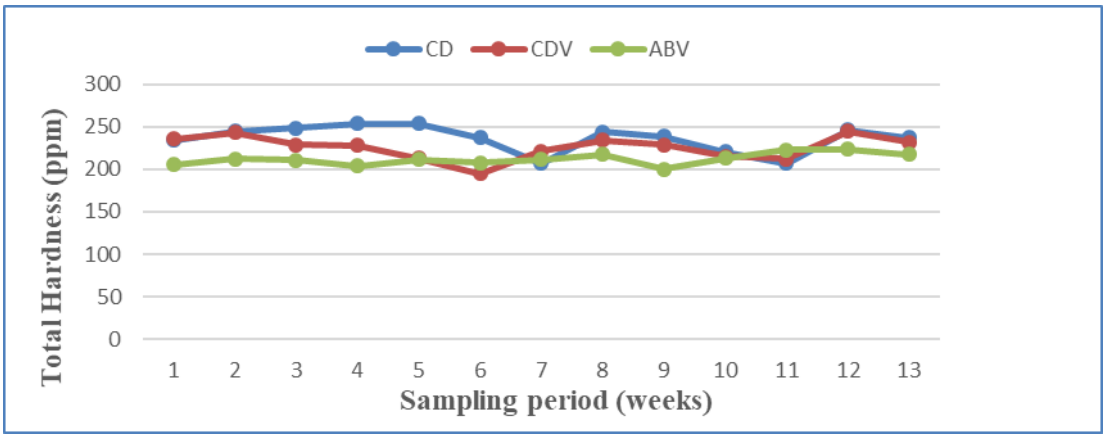

Fig. 6. Total hardness (ppm)

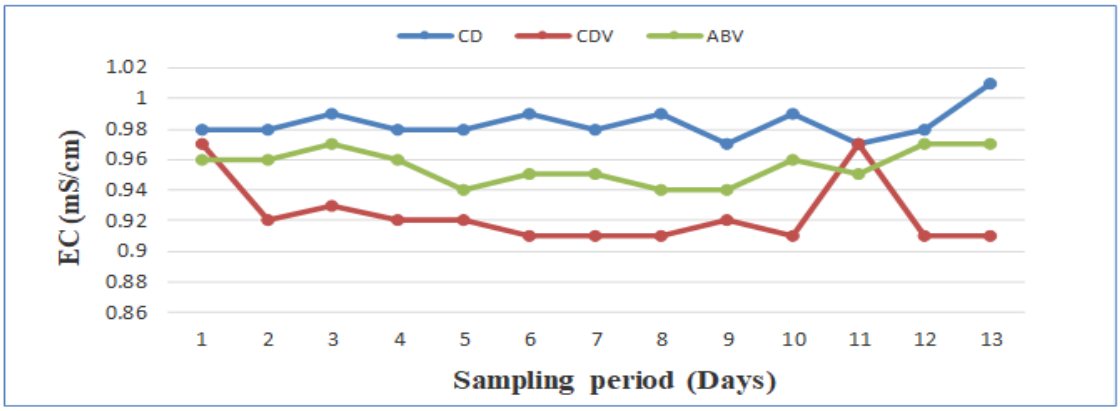

Fig. 7. Electrical conductivity (mS/cm)

3.2 Growth Parameters of Experimental Fishes

The study revealed that during the experimental period, growth parameters across three treatments: CD, CDV, and ABV (Table 1). Total weight gain (g) was found to be maximum (2.63±0.14) in ABV, followed by CDV (1.28±0.05) and minimum (0.55±0.02) was observed in CD. Total length gain (cm) was similarly found at maximum (3.47±0.22) in ABV, (2.94±0.32) in CDV and minimum (1.70±0.094) in CD. The value of specific growth rate (SGR) in cow dung, cow dung-based vermicompost and azolla-based vermicompost was found to be (0.42±0.02), (0.59±0.03) and (0.68±0.01). The survival rate was consistently 100 % across all treatments. Percentage Weight Gain (PWG) increased from (193.46±6.03) in CD to (317.26±34.9) in CDV, and (359.96±24.8) in ABV. These findings showed that growth performance significantly improved when going from CD to ABV treatments.

Table 1. Growth parameters in different treatments

Treatments / Growth parameter	CD	CDV	ABV
Total weight gain (g)	0.55±0.017	1.28±0.05	2.63±0.14
Total length gain (cm)	1.70±0.094	2.94±0.317	3.47±0.22
SGR (%)	0.42±0.023	0.59±0.028	0.68±0.016
Survival Rate (%)	100±0.0	100±0.0	100±0.0
PWG (g)	193.46±6.03	317.26±34.9	359.96±24.8

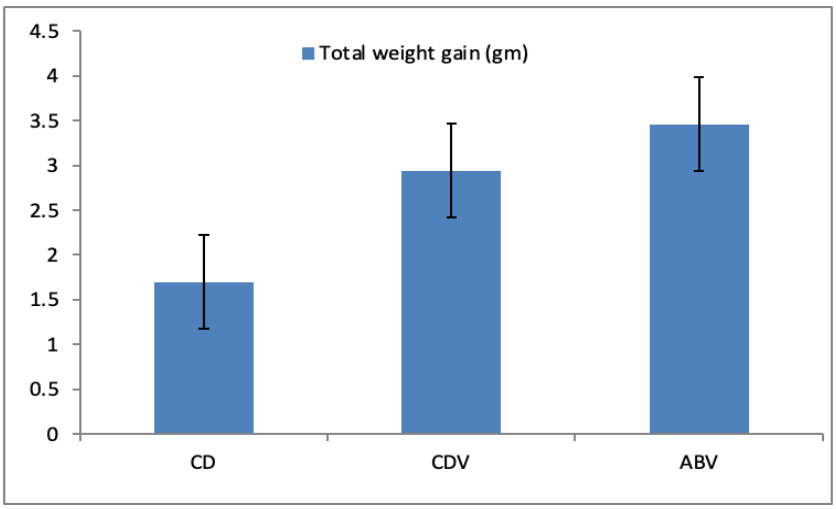

Fig. 8. Total weight gain

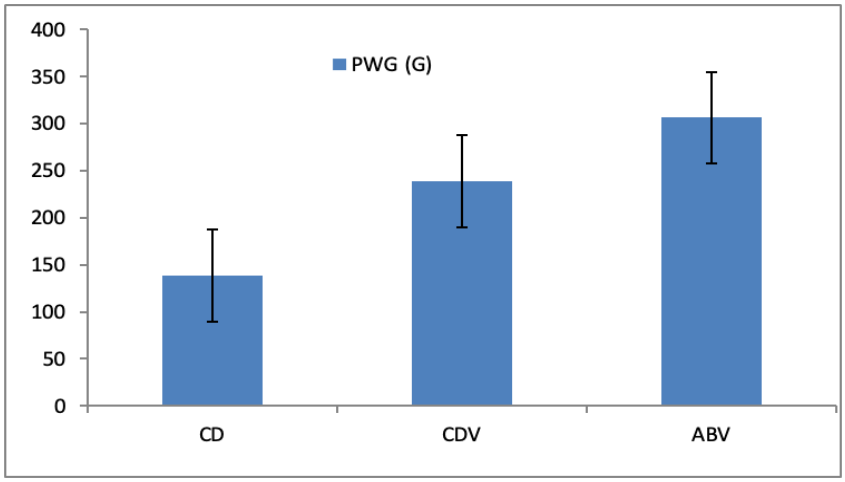

Fig. 9. Percent weight gain

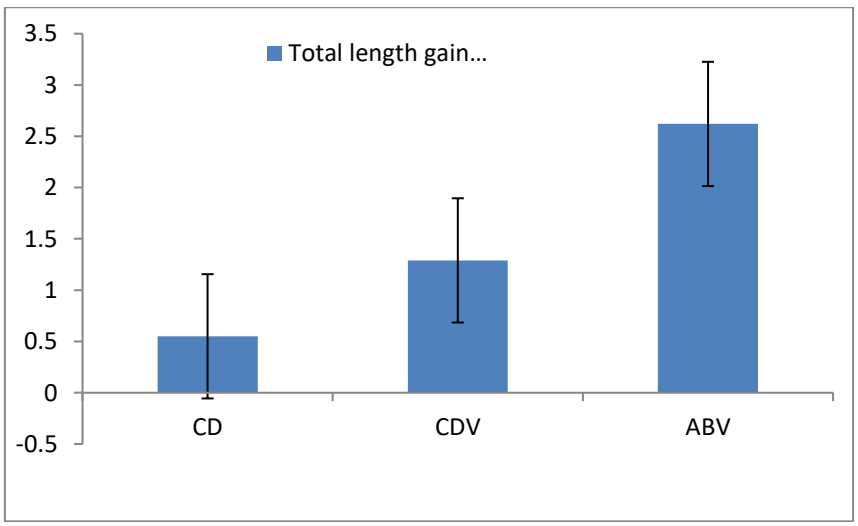

Fig. 10. Total length gain

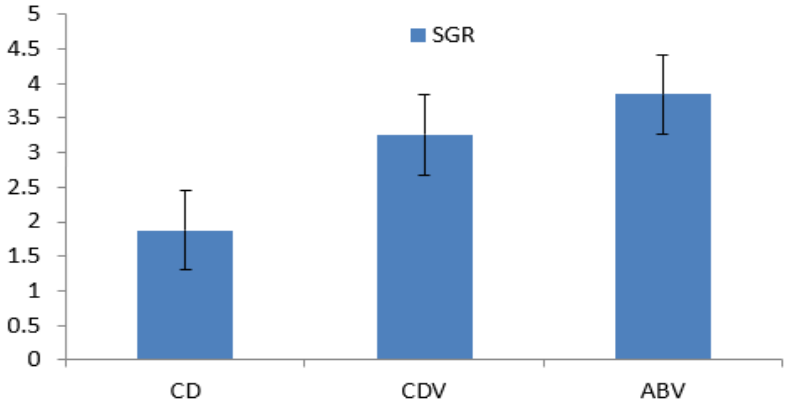

Fig. 11. Specific growth rate

4. DISCUSSION

The research evaluated the effects of cow dung (CD), cow dung-based vermicompost (CDV), and Azolla-based vermicompost (ABV) on various water quality parameters in sodic soil conditions. Noteworthy variations were recorded among the treatments, with ABV demonstrating the most significant reduction in pH levels, dropping from 8.88 to 8.20. This indicates its exceptional ability to alleviate soil alkalinity**.** Deolalikar and Mitra (2004) indicated that vermicompost demonstrated similar efficacy compared to other commercial manures utilized in aquaculture. The use of vermicompost has been found to lead to increased survival and growth of aquatic organisms such as fish and prawns without detrimental effects on water quality, as reported by Kumar et al. (2007). Chakrabarty et al. (2008, 2009) revealed notable enhancements in plankton production and fish growth (particularly in common carp) in ponds treated with vermicompost, as compared to those utilizing conventional organic manures and inorganic fertilizers. The current study confirms Ansal et al. (2006) findings, which showed that vermicompost manured ponds had far greater dissolved oxygen levels than cow dung. Maximum fish yield in ABV can be attributed to higher zooplankton production and better water quality in terms of high dissolved oxygen values. Vermicompost has a larger potential for usage than cow dung, according to Kaur (2010), and as a result, it can be utilized more successfully for manuring semi-intensive carp culture ponds without negatively impacting the hydro-biological parameters.

The current study demonstrates the use of Azolla-based vermicompost both directly as manure for fish culture ponds and indirectly as feed (higher growth of *C*. *carpio*). As a result, using Azolla-based vermicompost not only adds manorial value but also lowers feed costs. Vermicompost can also be used for catfish ponds as Ghos (2004) found better growth in catfish, *Clarias batrachus* and higher water retention capacity in vermicompost-manured ponds as compared to inorganic fertilizer-treated ponds in monoculture practices. Based on the results of Kaur and Gupta (2016) utilization of vermicompost for the growth of *Catla catla* in all treatments also showed varied significance.

5. CONCLUSION

It can be concluded that Azolla-based vermicompost is a more promising option than cow dung and cow dung-based vermicompost for manuring semi-intensive carp culture ponds. In fact, it can be used more effectively in this context without affecting the hydro-biological parameters. Specifically, the treatment with Azolla-based vermicompost @15 t/ha/yr showed superior results in terms of total weight gain, per cent weight gain, total length gain, and specific growth rate when compared to treatments with cow dung or cow dung-based vermicompost. These results indicate that Azolla-based vermicompost is effective in promoting fish growth in aquaculture settings.

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 writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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