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Effect of processed kidney bean (*Phaseolus vulgaris - Pinto group*) seed meal on water quality parameters of the *Cyprinus carpio* (Linnaeus, 1758) fingerlings

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Abstract
The purpose of the current study was to determine the " Effect of Processed Kidney bean *(Phaseolus vulgaris - Pinto group)* seed Meal on water quality parameters of the *Cyprinus carpio* (Linnaeus, 1758) Fingerlings". For 60 days, the current experiment was accomplished from 4 April 2023 to 4 may 2023, at Department of Aquaculture, COF, MPUAT; Udaipur (Rajasthan). Around 200 healthy fingerlings of common carp were used for the experiment. To feed the fish, T_1 (5%), T_2 (15%), T_3 (25%), T_4 (35%), T_5 (45%) and T_0 (excluding Processed Kidney bean meal), amounts of processed kidney bean meal inclusion were employed. Feed was given twice a day. In the form of spaghetti, fingerlings were fed at the rate 3% of their body weight. During the whole experimental period, there was no negative influence of processed kidney bean meal can be observed on water quality metrics as the values of water quality parameters only indicate some slight changes across different treatments. Physical and chemical parameters of the water, including its temperature (26.2 to 30.5 °C), electrical conductivity (176 -214 µS/cm), pH (6.4-8.4), dissolved oxygen content (5.6 to 8.2 mg/l), total alkalinity (102 -168mg/l) and total hardness (400-491 mg/l) were evaluated in every 15 days interval. These findings support the hypothesis that processed kidney bean meal supplementation as fish feed were both safe for water quality and beneficial for *Cyprinus carpio* fingerling's growth.

Keywords: Common carp, water quality metrics, processed kidney bean meal, *Phaseolus vulgaris*

Introduction
Fisheries and aquaculture industries have gained more recognition in recent years for their critical role in ensuring global food security and nutrition. (Handbook on Fisheries Statistics, 2023). The world's growing population has been fed and nurtured through aquaculture, which has the ability to raise socio-economic status of nations. 2020 saw a record-breaking 214 million tons of fisheries and aquaculture production, worth about USD 424 billion. The amount destined for human consumption (excluding algae) was 20.2 kg per capita, Aquatic food consumption is anticipated to rise by 15% by 2030, reaching an average of 21.4 kg per person, as a result of rising incomes, urbanisation, better post-harvest procedures, and dietary patterns. A record 122.6 million tonnes of aquaculture production were produced worldwide in 2020. (SOFIA 2022) [28].

Indian Fisheries sector evolved gradually over the years and became an important socio-economic attribute for the nation. After China, India is the third-largest fish and aquaculture producing country and India's overall share to World fish production was approximately 8%. India's fish production was 162.48 lakh tonnes overall in the year 2021–2022, respectively. Andhra Pradesh state tops in the inland fish production, followed by other states. The Annual Growth Rate of Fish Production is 10.34%, 2020-21 (Handbook on Fisheries Statistics, 2023).

Rajasthan state has enormous potential to raise aquaculture and fisheries production due to availability of sufficient numbers of water resources. Rajasthan's inland fish production was 0.66 lakh tonnes in the year 2021-22, Indian Major Carp's and exotic carp's contribute to around 0.42 and 0.11 lakh tonnes to Rajasthan inland fisheries. (Fisheries Statistics current report, 2023).

One of the first fish species to be domesticated for aquaculture purpose is the common carp *(Cyprinus carpio)* Linnaeus, (1758). Common carp is the third most widely cultivated and commercially important freshwater fish species in the world.

Among the cyprinids, the Common carp output has increased by double in the past ten years. It was largely influenced by the cultures of Asian nations like China, India, etc. India's fish production has increased due to the common carp, which contributes to overall inland fish production.

Feed accounts for more than 60% of the production's input costs in aquaculture. In both semi-intensive and intensive fish farming, feed is the most expensive cost factor. In fact, the variable cost of a carp culture operation accounted just by feed expenses in two-thirds of its cases (Jauncey *et al.* 1982) [15]. An important aim of research in fish production is to enhance cost effective aquaculture production while providing adequate animal protein and fish by-products for human consumption. The ever-increasing human population necessitates the need to source for alternative feeds and feedstuffs for fishes to attribute the best growth under different aquaculture conditions. Therefore, it would be economical to take advantage of Plant-based protein sources which will amplify fish production. Plant-based protein sources may hold the key solution because they are cheap, readily available and high in protein, claim Chakraborty *et al.* (2019) [8]. To accomplish the ultimate aim of high profit from carp culture, it is therefore essential to include alternative plant-based ingredients into feed, from which feed quality will be improved without compromising the growth of fish. Kidney bean *(Phaseolus vulgaris)* is one of the possible substitute ingredients used in the supplementary feed as it is an excellent provider of nutrients, including proteins, carbohydrate, minerals and vitamins as per Rehman & Shah (2004). According to Thani *et al.* (2018) [32] Kidney beans have a comparatively high nutritional content and is a rich source of protein. Therefore, Kidney bean (*Phaseolus vulgaris L.*) might be used as animal feed additives. The minerals in the seeds imply that they are suitable as viable animal feed ingredients. Thus, it was needful to work on the "Effect of Processed kidney bean *(Phaseolus vulgaris - Pinto group*) Seed meal on water quality parameters of the *Cyprinus carpio* Fingerlings".

Materials and Methods

This study was performed for 60 days, from 4 April 2023 to 4 may 2023, at the wet lab of the Department of Aquaculture, College of Fisheries, Udaipur (Rajasthan). The Aquaculture Research and Seed Production Unit, Directorate of Research, MPUAT, Udaipur, provided 200 common carp fingerlings. The fishes were placed in the FRP plastic tanks (500 litres capacity) and fed with a control diet (Groundnut oil cake and rice bran 1:1) for a week, prior to the commencement of the experiment to acclimatize them to the experiment diet and environment. In the experiment, 18 FRP tanks with a volume of 225 litres were utilized. After a week, the healthy fingerlings of common carp having unvarying size will be randomly allocated in five experiment treatments groups and one control group, with each of the three replicates following a completely randomized design. Each tank will be stocked with 10 common carp fingerlings. Feed was given twice a day, in the morning hrs. at 10 AM and in the evening hrs. at 5 PM. In the form of spaghetti, fingerlings were fed at the rate 3% of their body weight.

Water quality analysis

In Every 15 days during the experimental period, the water quality was evaluated. All 18 tanks were thoroughly cleaned before fishes were placed within and filled with 200 litres of filtered subterranean water. During experimental period fishes were carefully handled with the help of hand net, in the tank. To maintain the desired water quality, Siphoning was done in every 12-14 days and water was replaced and refilled as needed. Selected water quality parameters, including water temperature (°C), pH, Dissolved oxygen (mg/l), Total alkalinity (mg/l), Total hardness (mg/l) and Electrical conductivity (µS/cm), were tested initially and at intervals of 15 days, according to the standard procedure of APHA (2005) [5].

Results and Discussion

A commercial aquaculture enterprise's success depends on providing an ideal environment for rapid development of aquatic organisms (fishes, prawns etc.) at the lowest possible cost of resources and capital. The sum of all the physical, biological and chemical parameters that impact the growth and welfare of cultured organisms is referred to as water quality. Water quality influences the overall state of cultured organisms since it directly or indirectly regulate their health and growth circumstances. Water quality is thus an important aspect to consider when planning for high aquaculture production.

Water Temperature

Temperature tolerance limitations are well recognised in every type of organism, including fish. Temperature also alters the dissolved oxygen content in the water. Water temperature has a significant impact on fish ingestive variation, reproductive development and breeding period. The chemical changes in both soil and water are greatly influenced by temperature. The higher the temperature, the greater the need for oxygen and food, and the faster the growth rate. Temperature also has an important influence in provoking gonadal development and spawning activity in carps. Takeuchi *et al.* (2002) [30] revealed that the preferred ideal temperatures for common carp growth were lie between 30 and 32 °C. Sapkale *et al.* (2011) [23] in his findings concluded that estimated best temperature for the growth of spawn of *Cyprinus carpio* is at 26 °C water temperature. M. Flajšhans and G. Hulata (2007) [11] research report, in which he shows that Common carp best growth was obtained at water temperature of 23-30 °C. During the current research work, the water temperature was between the ideal range of 26.2 to 30.5 °C, which is similar to the data mentioned in Handbook of fisheries and aquaculture (2019) [23] that the temperature required for the optimum growth of carps are 27° to 32 °C.

Electrical conductivity

The capacity of water to conduct electrical current due to the presence of ions in it is referred to as EC. Electric conductivity (EC) is typically measured in Siemens per metre (S/m). The ions in water determine the EC of water. Conductivity is a measure of the overall ionic content of water. The electrical conductivity (EC) range of 140 to 182 µS/cm showed in Rao *et al.* (2023) [22] research paper suggested that this range was ideal for common carp fingerling's growth. During the present study, EC was found between 176-214 µS /cm and was ideal for fish growth.

pH

The concentration of hydrogen ions in water is measured as pH, which shows the acidity and alkalinity (basicity) of the water. Fish metabolic and physiological processes are affected by pH. The optimum pH required for the for the growth of carps are 7.5 to 8.3 as per Handbook of fisheries and aquaculture (2019) [23]. Sapkale *et al.* (2011) [23] concluded that the estimated best pH is 7.3 and can promote maximum growth of C. carpio spawn. Wu *et al.* discovered that a pH range of 7.0-8.0 generated the optimal functioning of numerous physiological responses and enzyme activity in carp. According to Heydarnejad (2012) [14], common carp survive and thrive best when exposed to water pH levels ranging from 7.5 to 8.0. During the recent study, the pH ranged from 6.4 to 8.4, indicating that the water was moderately alkaline.

Dissolved oxygen

The most essential aspect of water quality is dissolved oxygen in the aquaculture environment. In intensive aquaculture, dissolved oxygen is the most crucial and limiting factor. Animals will be stressed if proper DO levels are not maintained, making them prone to sickness and mass mortality. According to Boyd (1979) [7], the most important factor in preserving fish life and survival is dissolved oxygen. The optimal DO concentration for a fish pond is normally maintained at 5mg/l to saturation level for healthy fish growth and reproduction in tropical waters. During the present study, dissolved oxygen was found between 5.6-8.2 mg/l. According to Bhatnagar and Singh (2010) [25] and Bhatnagar *et al.* (2004) [26], a DO level of more than 5ppm is required for excellent fish production.

Total Alkalinity

Alkalinity refers to the total amount of bases in water. Ponds with alkalinity of 50 ppm were described as productive and alkalinity of 90-100 ppm are highly productive water. According to Handbook of fisheries and aquaculture (2019) [23]; A total alkalinity of 80-120 mg CaCO3/litre is ideal for carp's growth. According to Alikunhi (1957) [3], the alkalinity in highly productive water should be greater than 100 ppm. According to Santhosh and Singh (2007) [34], 50-300 mg/l alkalinity is optimum for fish production. Alkalinity in an aquaculture pond was ideal between 75 and 200 mg/l, according to Wurts and Durborow (1992) [33]. During the recent study, the alkalinity range was found to be between 102 and 168 mg/l.

Total Hardness

According to Swain *et al.* (2020) [29], Water hardness is defined as the sum of all divalent cations, especially calcium and magnesium. It is regarded as a significant abiotic factor impacting aquaculture. It is commonly expressed as mg/L calcium carbonate (CaCO3). He found that generally, calcium is more important than magnesium in aquaculture water management since it is necessary for the water hardening of newly fertilized freshwater fish egg and calcification of larval skeletal structure. Sinha *et al.* (2018) [27] reported that the species (catla, rohu and mrigal) showed maximum growth at a hardness of 180 mg/l. Fish grow well over a wide range of hardness, although range of 120 to 400 ppm are optimal; nevertheless, her research study suggests that even higher values of hardness are more favourable for major carp's growth. During the current research study, the hardness varies from 400-491 mg/l. The hardness range of 420 to 664 mg/l, according to Matoria *et al.* (2020) [19], was appropriate for the growth of fish.

Table 1: Range and mean value of water quality parameters during experimental period of 60 days in different treatments

Parameters	T_0	T_1	T_2	T_3	T_4	T_5
Water Temperature (°C)	26.2-30.2 (27.81)	26.4 - 30.5 (27.97)	26.4-30.4 (28.08)	26.3-30.4 (28.19)	26.4-30.2 (28.12)	26.4-30.2 (28.07)
pH	7.1-7.9 (7.49)	6.8-8.1 (7.46)	6.8-8 (7.53)	6.7-7.8 (7.31)	6.4-8.4 (7.43)	6.9-8.1 (7.53)
Dissolved oxygen (mg/l)	6-8 (7.26)	5.6-7.4 (6.68)	6.4-7.9 (7.38)	6-7.8 (7.21)	5.6-8.2 (6.93)	6-7.9 (7.0)
Total Alkalinity (mg/l)	102-151 (132.0)	128-151 (138.4)	125-159 (141.8)	130-152 (139.6)	129-168 (144.1)	112-164 (140.5)
Total Hardness (mg/l)	410-480 (443.7)	410-479 (438.0)	417-470 (438.6)	400-480 (448.0)	420-491 (457.1)	410-479 (450.5)
Electric conductivity (µS/cm)	182-209 (192.3)	179-211 (193.3)	179-212 (194.5)	178-212 (193.0)	176-214 (192.9)	176-204 (192.3)

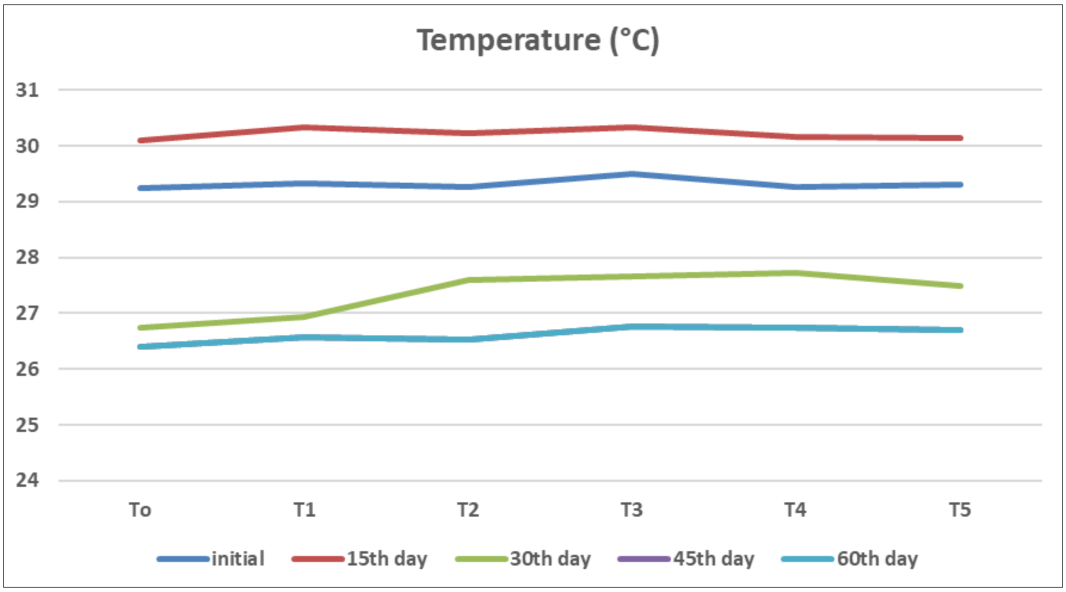

Fig 1: Water temperature during the experimental period of 60 days in different treatments.

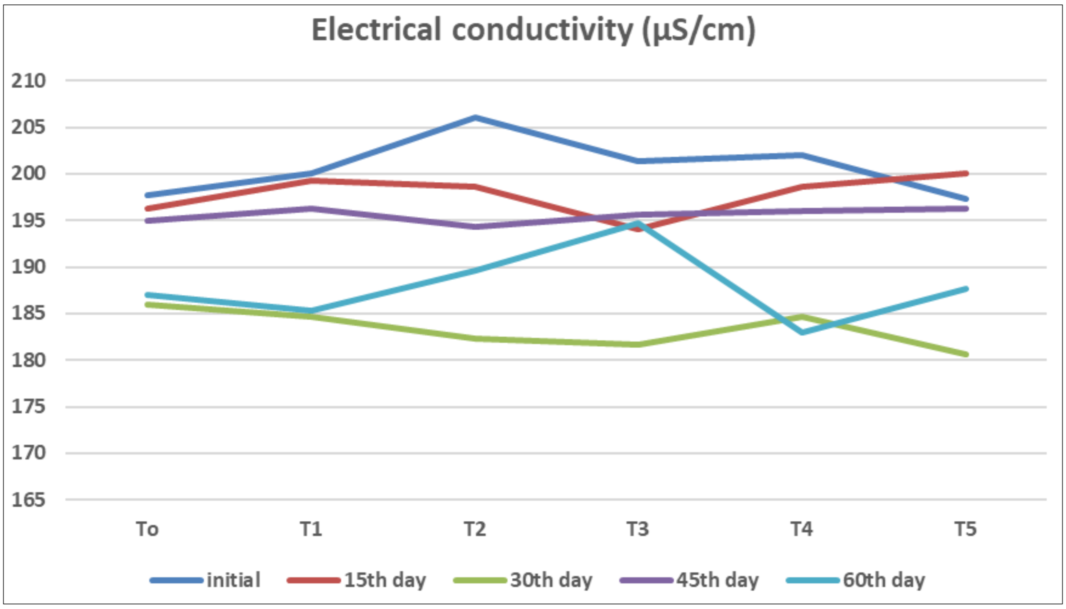

Fig 2: Electrical conductivity of water during the experiment in different treatments

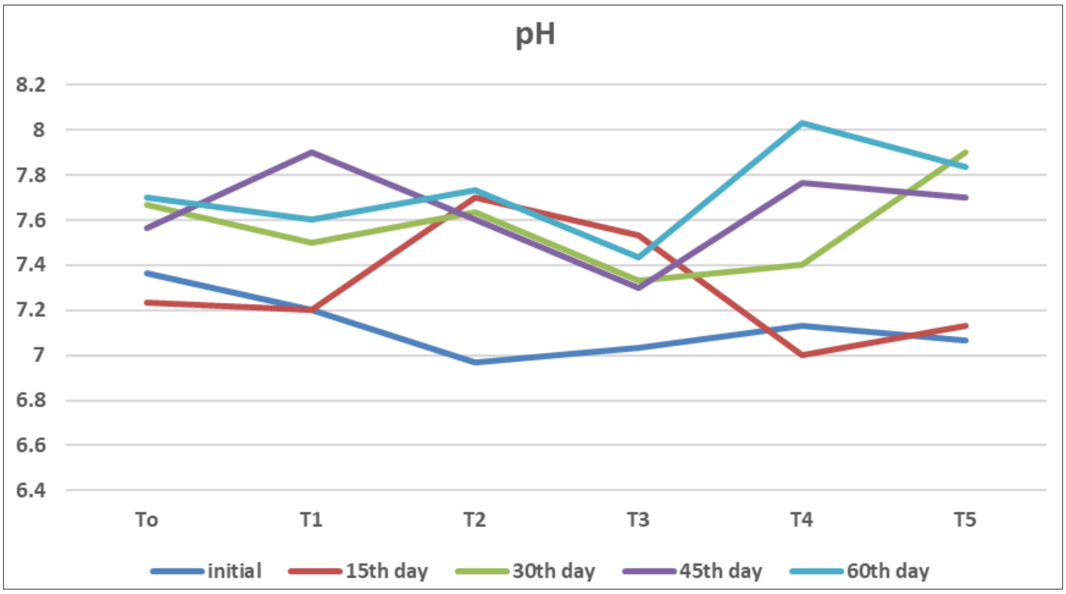

Fig 3: pH of water during the experiment in different treatments

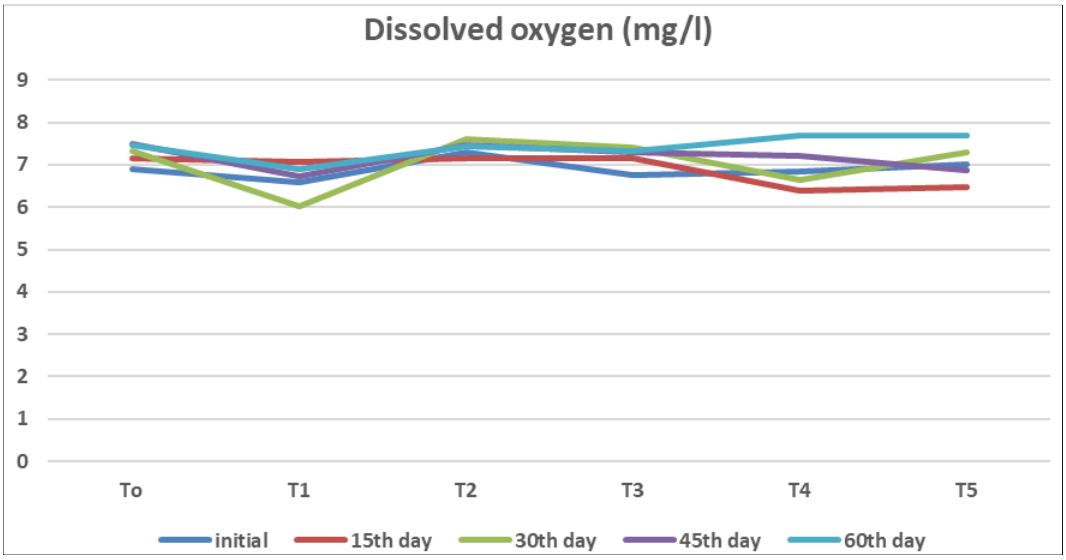

Fig 4: Dissolve oxygen in water during the experiment in different treatment

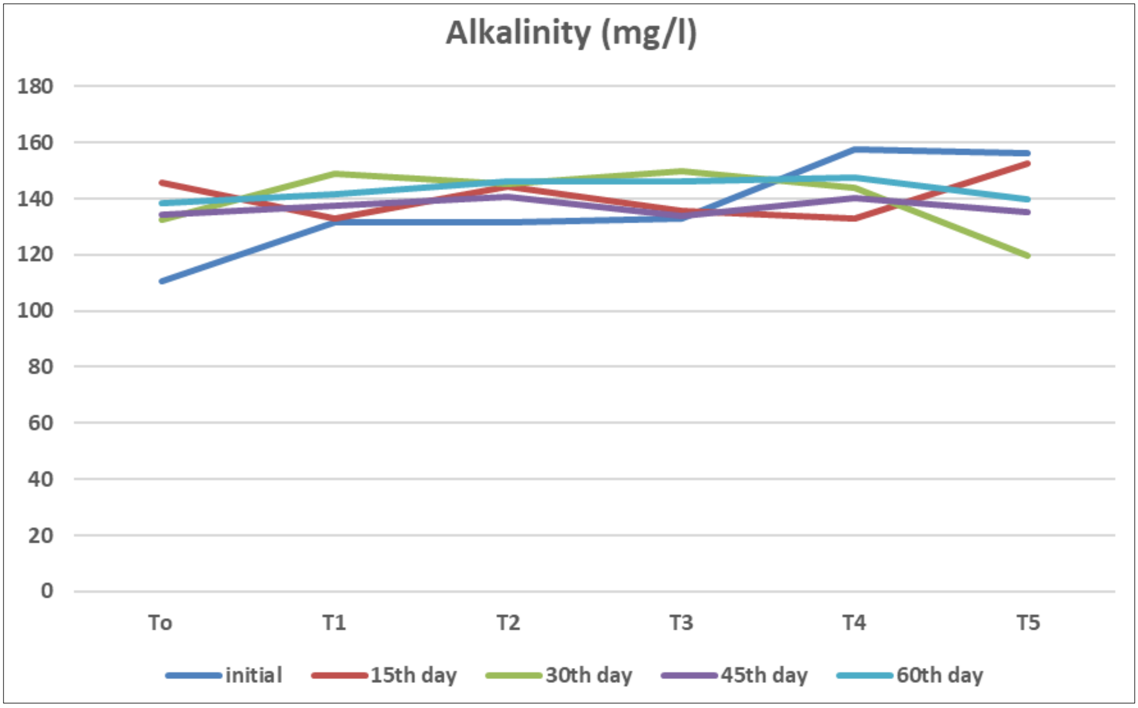

Fig 5: Alkalinity of water during the experiment in different treatments

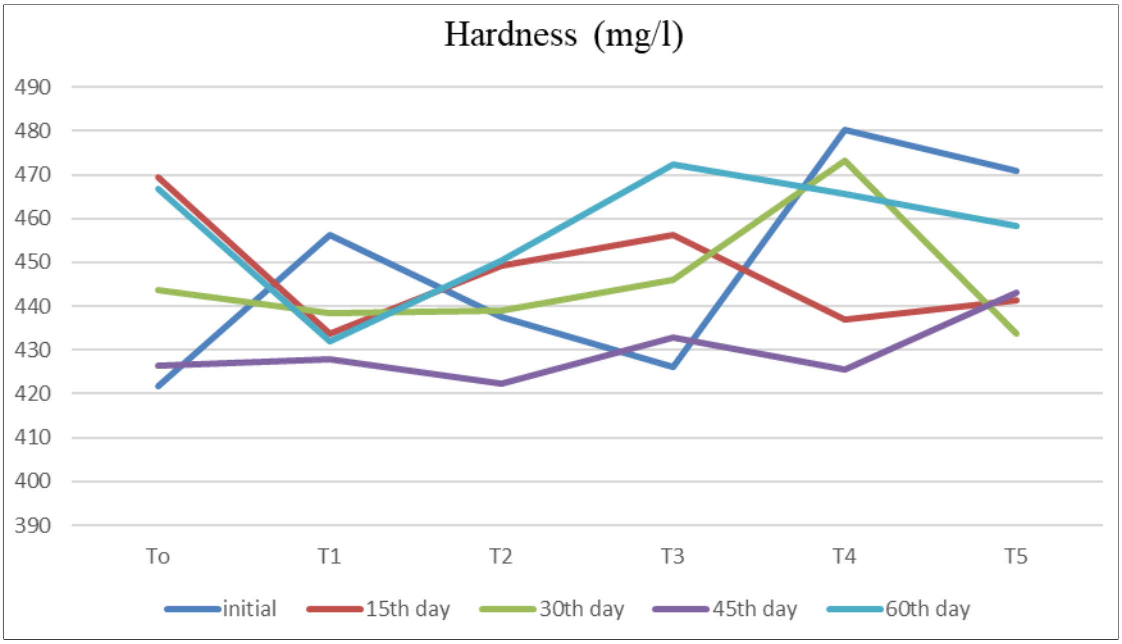

Fig 6: Hardness of water during the experiment in different treatments

Conclusion

The current study findings concluded that water temperature, EC, pH, DO, Total alkalinity and Total hardness recorded, was in optimum range and all the treatments had no detrimental effects on fish growth. Thus, it can be supported by the conclusion that processed kidney bean meal is both safe and beneficial for the growth of *Cyprinus carpio* fingerlings and favourable for water quality.

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