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RESEARCH ARTICLE

EFFECT OF WATER HYACINTH LEAF SUPPLEMENTATION ON GROWTH PERFORMANCE OF CAGED COMMON CARP (*CYPRINUS CARPIO*)

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ABSTRACT

Effect of water hyacinth leaf supplementation in the performance of caged common carp (*cyprinus carpio*) were evaluated. The different levels of water hyacinth leaf meal supplementation in the different experimental diets were 0%, 10%, 15% and 20% (with crude protein content of 35%). The performance were evaluated using 12 cages (1 m^3) at Institute of Agriculture and Animal Science, Paklihawa campus, Bhairahawa for 90 days (26th August of 2023 to 19th November of 2023). Common carp fries were randomly distributed into cages at 10 fry/ cage. The experiment were conducted in Completely Randomized Design (CRD) with four treatments replicated thrice. The treatments were: T1: Control (Basal diet), T2: 10% replacement of Soybean Meal (SBM) with Water Hyacinth Leaf Meal (WHLM) in Basal diet, T3: 15 % replacement of SBM with WHLM in Basal diet, T4: 20% replacement of SBM with WHLM in Basal diet. The pelleted feed containing 35% CP were maintained at the rate of 5% of body weight in initial month followed by 3% in the following months. Fish were fed once daily at morning between 8:00-9:00 a.m. Mean weight of fry during stocking period were 46.5±7.16g, 45.4 ±6.54 g, 45.3±4.46 g, 41.6±1.73g in treatments T1, T2, T3 and T4 respectively. Final mean weight of fish was highest in T3 (159.3±6.23g) at the 90 days after stocking which were significantly higher than T1 (123.6±8.12g), T2 (131.6±7.21g), T4 (108.4±1.74g) at ($p<0.05$). Similarly, the Specific Growth rate (SGR) value was highest (1.4±0.06g) in T3 while T4 (1.0±0.04g) was found to be the lowest. The survivability was recorded in a range of (76.6-90). Highest Benefit Cost ratio (BCR) was recorded in T3 (1.27±0.01) which were significantly different with T1(0.94±0.02), T2(1.04±0.02) and T4(0.97±0.008) ($p<0.05$). The gross return was found highest in T3 (58.95±2.30) and lowest T4(40.12±0.64) ($p<0.05$) while the net return was also highest in T3 (12.69±1.65) and lowest in T1 (2.43±1.34) ($p< 0.05$). So, we can suggest T3 (Replacement of 15% water hyacinth powder) as partial alternative of soya bean meal powder in fish feed.

KEYWORDS

Feed Supplementation, Growth Performance, Water Hyacinth, Common Carp

1. INTRODUCTION

Common carp is a warm-water fish that inhabits in temperatures between 3 to 35 °C. Shallow waters are their home. They are more popular than silver carp and fetch a greater price, despite being regarded as invasive species (Chandra, 2016). Common carp is the important farmed fish with a high production rate, rapid growth, tolerance to difficult environmental conditions (Gupta et al., 2005). At present 252 species of fishes are found in Nepal (Shrestha, 2019). The 1950s saw the introduction of common carp to Nepal, while the 1970s saw the introduction of Chinese carp varieties such big head, silver, and grass carp (Karki, 2016). In 1972, cage culture was first introduced in Nepal at Lake Phewa, Pokhara. Carp is the second most popular fish after silver carp and commands a higher market price (Chandra, 2016; Swar & Pradhan, 1992). The common carp, belonging to the class Osteichthyes (Teleostichthyes), Cyprinidae and Cyprinidae, is the most commonly farmed and most important commercial fish of high economic importance. In Nepal, according to the DOFD results as obtained from (Ranjan, 2019), Mrigal were the highest (29.2%), followed by Carp (19.2%) and Rohu (12.2%). Carp lives on the bottom and feed on bottom insects, insect larvae, zooplankton, dead and rotting plants (Jhingran VG, Pullin RS 1985).

Fish production in Nepal is still subsistence type where carp are of higher importance as they can sustain with natural food. Majority of the fish-farmers adopt extensive and semi-intensive system and carp culture dominate the production (about 90%) (CFPCC, 2018). Selecting the right feed ingredient is one of the biggest challenges among them (Bogati, 2018). Of the total costs of production, feed accounts for only over 60% of the total costs incurred (Raseduzzaman et al., 2014). The high cost of commercial feed and conventional feed ingredients makes fish feed prohibitively expensive for the average fish farmer. Fish Diet accounts for 30–70% of overall operating costs; choosing the right feed ingredient appears to be crucial (Nekoubin and Sudager, 2012). Research findings indicate that plant-based protein sources possess significant promise in providing fish with the necessary protein for optimal fish productivity (Dienye and Olumuji, 2014). Commercial pellet is costly, which raises the production cost. The ultimate goal of farmers is to maximize production at the lowest possible cost (Olaniyi et al., 2013). A variety of plant protein sources are being used over time to solve this problem. These are suitable diets for partial or complete replacement of fishmeal in fish diets (Hardy, 2010).

Water hyacinth can be used as fish feed as it is a good source of nutrients. It reproduces by sending forth runners or stolon's that give rise to daughter plants. It yields a lot of seeds, some of which can last up to thirty years (Simpson and Sanderson, 2002). Because water hyacinth is so tenacious, it will cover the whole surface of the water, blocking fish and turtles from getting enough sunshine and oxygen to survive. Additionally,

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it provides a breeding environment for other vectors including mosquitoes (Opande et al., 2004). Inclusion of, locally available feed ingredients can aid in cost reduction while maximizing profit (Olaniyi et al., 2013). The ingredients used should have a reasonable asking price and excellent nutritional value. Although locally accessible soybeans were initially employed as a substitute for fish meal as a source of plant protein due to the higher expense of fish production, this practice has since changed (Yuangsoi and Masumoto, 2012).

Therefore, this study was conducted, to evaluate the effect of water hyacinth leaf meal on growth performance of the caged common carp fry and to optimize the inclusion rate of the water hyacinth leaf meal in common carp feed.

2. Materials and Method

This research was conducted at the pond situated at the Institute of Agriculture and Animal sciences, Paklihawa, rupandehi, Nepal. This research was conducted from 26th August of 2023 to 19th November of 2023. Water hyacinth leaves were collected from nearby fields surrounding the college, cleaned with water, and then left to soak overnight. The following morning, the leaves was stored for blanching to prevent enzyme deactivation. In order to blanch a plant, it was boiled for 10 minutes at a temperature between 75 and 107˚C. Celsius. In order to prevent the loss of nutrients that are heat-sensitive, it was rapidly chilled after blanching. After cooling in a large pot with ice and a small amount of table salt, the cured leaves were dried in a room with good ventilation. A fan was utilized to help with quick drying. The dried leaves were then chopped up and powdered to be used as fish ingredients.

The experiment was carried out in 12 fish cages measuring 1 cubic meter, with mesh sizes of 0.8 mm. Four bamboo poles were used to support each cage in its upper four corners. To keep the cage's construction intact, the lower corners was tied with ropes and secured to the stone. On the top face, a small feeding hole was made available. Viable-sized fry from the Mandal Hatchery in Patthardanda, Rupandehi were placed in plastic bags containing oxygen and water and allowed to acclimatize for 7 days before starting the experiment. During acclimation, extruded commercial diet was feed containing 28% crude protein before using the test diet. The fry was then transferred to individual cages at a stocking density of 10 fish per cage and fed once daily with appropriate food according to treatment.

For the experiment, Completely Design (CRD) was used having the four experimental diets.

T1: (Basal diet containing Soybean meal, Rice bran, and Mustard oil cake)

T2: (10% replacement of soybean meal with water hyacinth leaf powder in Basal diet),

T3: (15% replacement of soybean meal with water hyacinth leaf powder in Basal diet),

T4: (20% replacement of soybean meal with water hyacinth leaf powder in Basal diet)

Altogether there were four treatments replicated 3 times. The lottery method was used to randomize the treatments.

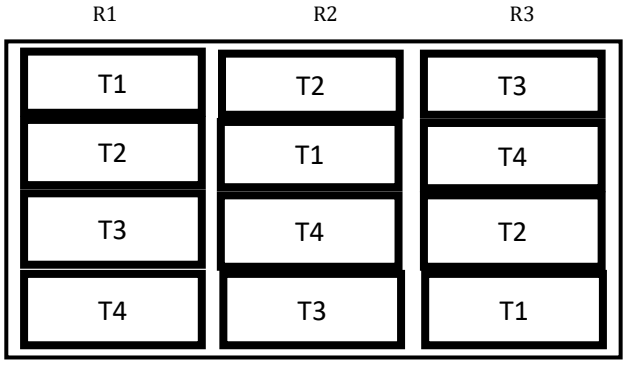

Figure 1: Layout of the research.

Four ingredients, soybean meal, rice bran, mustard oil cake meal, and water hyacinth leaf meal, were used to prepare the test meals. Soybean meal was selected as a protein source and rice bran as a carbohydrate and energy source. Control diets were prepared using rice bran, soybean meal, and mustard meal. These ingredients were grinded into a fine powder and the mustard oil cake was soaked before being ground. A mixture of vitamins and minerals was added. As recommended for treatment combinations, test meals were prepared with water hyacinth leaf powder added. The prepared leaf powder was stored at 4°C until use. Dietary Analysis. of water hyacinth leaf powder, mustard meal, rice bran and soybean meal were conducted at the Central Fisheries Promotion and Conversation Center, Balaju, Kathmandu. Feeds were created using a trial-and-error method in a programmed MS Excel spreadsheet. Prepared feed pellets were sun-dried and used for feeding activities.

Table 1: Ingredients and Constituents (g) of the experimental diets.

Ingredients	Control T1	T2	T3	T4
Soybean meal	50	40	35	30
Water hyacinth	0	10	15	20
Mustard Oil Cake	28	38.5	44	48
Rice bran	21	10.5	5	1
Vitamin and Mineral Premix*(Agrim Fort)	1	1	1	1
Total	100	100	100	100

Dissolved oxygen (DO), pH, and temperature was measured weekly at 6-7 a.m. using a Lutron WA-2015 handheld multimeter. Temperature in degrees Celsius (^{0}C) and dissolved oxygen in parts per million (mg/L) were recorded for each monitored value. Secchi discs was used for clarity. Four meals were prepared with the same dietary protein content of 35%. Control diets containing no water hyacinth and 10%, 15% and 20% soybean meal replaced with water hyacinth leaf meal was conducted. All ingredients are thoroughly ground, sifted through a mesh size of 0.5 mm, mixed and fed to a manual pellet machine (Engineering Industries Private Ltd.) to produce 3 mm food pellets.

Fish were hand-fed with prepared pellet according to the total weight of the fish in each cage. Fish were fed once daily between 8:00-9:00 a.m. The first month fish were fed 5% of the body weight, the next two month with 3%. Each month, 30% of the total fish were seine netted from each cage to assess its growth performance. Data were collected based on weight (g) using an electronic compact scale (Kerro series P3 BL5002 Max-500g, D=0.01g).

The growth parameters were calculated using following formula (Usandi *et al*., 2019).

- Specific Growth Rate (%):

$$\frac{[\log(\text{Final Weight})(g)] - [\log(\text{Initial Weight})(g)]}{\text{Time interval in days}} \times 100$$

- Survival Rate (%):

$$\frac{\text{Total number of fish havested}}{\text{Total number of fish stocked}} \times 100$$

- Daily weight gain(g/day) = (Mean Final weight – Mean Initial Weight) ×100 / Experimental Period
- Net Fish Yield (ha^{-1} yr^{-1}) = Harvest Weight (Kg)-Stocked Weight (Kg) ×10×365/culture area × Culture Period

Table 2: Proximate composition of locally prepared Water Hyacinth leaf meal expressed in percent dry weight used in the experiment.

Constituent	Water Hyacinth (Mean %)	Rice Bran (Mean %)	Mustard Oil Cake (Mean %)	Soybean Meal (Mean %)
Moisture	13.24	12.53	9.76	8.57

Table 2 (cont): Proximate composition of locally prepared Water Hyacinth leaf meal expressed in percent dry weight used in the experiment.				
Protein	16.31	12.4	32.05	37.17
Ash	8.03	6.93	10.81	10.81
Fat	0.83	7.20	9.48	16.84
Fiber	2.97	2.79	1.67	0.97

Economic analysis of the experiment which was carried out for 90 days was carried out and the Total fixed cost, Total variable cost, Total cost Total return, Net return and Benefit cost ratio was calculated.

Mathematically,

Total Cost = Total fixed cost + Total Variable Cost

Gross Return = Total return obtained from the selling of common carp

Net Return = Gross Return – Total Cost

Benefit Cost Ratio = Total Benefit / Total cost

Data were managed and tabulated in Microsoft Excel 2013. The data analysis and graphical representation was done by using Microsoft Excel and R – Studio Software, Version: 2024.04.2+764.

3. Result and Discussion

Table 3: Mean value of growth parameters and survivability of common carp during experimental period of *90* days.

Treatment	Parameters				
	Initial mean weight (g)	Final mean weight (g)	Daily weight gain (g)	Specific growth rate (%)	Survivability (%)
T1	46.5±7.16^{a}	123.6±8.12^{bc}	0.8±0.02^{c}	1.1±0.09^{b}	*8*3.3±6.67^{ab}
T2	45.4±6.54^{a}	131.6±7.21^{b}	0.9±0.03^{b}	1.2±0.10^{ab}	*76.6*±3.33^{b}
T3	45.3±4.46^{a}	159.3±6.23^{a}	1.2±0.02^{a}	1.4±0.06^{a}	*90.0*±0.00^{a}
T4	41.6±1.73^{a}	108.4±1.74^{c}	0.7±0.01^{d}	1.0±0.04^{b}	*86.6*±3.33^{ab}
LSD (0.05)	17.58	20.63	0.08	0.25	0.41
Mean	44.74±4.97	130.77±5.82	0.95±0.02	1.19±0.07	81.61±3.33
F- Value	NS	**	***	NS	NS
CV (%)	20.87	8.37	4.83	11.39	13.58

Note: Different lowercase letters on same column indicate statistically significant difference between treatments (p< 0.05), as performed by the least significant difference.

Table 4: Feed Conversion ratio of common carp during experimental period of *90* days.

Treatment	Parameters
	Feed Conversion Ratio
T1	2.90±0.206^{a}
T2	2.67±0.204^{ab}
T3	2.14±0.115^{b}
T4	2.96±0.155^{a}
LSD (0.05)	0.57
Mean	2.66
F-Value	2.30
CV (%)	11.35

Note: Different lowercase letters on same column indicate statistically significant difference between treatments (p< 0.05), as performed by the least significant difference

Table 5: Comparative economic analysis for each treatment on m^3 basic per harvest (values are given as NRs).

Variable Cost	T1	T2	T3	T4
Common carp Fry	15	15	15	15
Feed	21.57±1.69^{a}	19.43±1.57^{a}	19.25±1.32^{a}	14.34±0.7^{b}
Sub Total Variable Cost	36.57±0.84^{a}	34.43±0.78^{a}	34.25±0.66^{a}	29.34±0.33^{b}
Fixed Cost				
Cage Depreciation (20%)	12±0^{a}	12±0^{a}	12±0^{a}	12±0^{a}
Sub Total Fixed Cost	12±0^{a}	12±0^{a}	12±0^{a}	12±0^{a}
Total Cost	48.57±0.42^{a}	46.43±0.39^{a}	46.25±0.33^{a}	41.34±0.16^{b}
Gross Return				
Common Carp	46.14±3.0^{ab}	48.71±2.67^{ab}	58.95±2.30^{a}	40.12±0.64^{b}
Total	46.14±3.0^{ab}	48.71±2.67^{ab}	58.95±2.30^{a}	40.12±0.64^{b}
Net Return	2.43±1.34^{b}	2.28±0.19^{ab}	12.69±1.65^{a}	1.22±0.08^{b}
Benefit Cost Ratio	0.94±0.02^{b}	1.04±0.02^{ab}	1.27±0.01^{a}	0.97±0.008^{b}

Table 6: Mean and Range of water quality parameters measured daily during experimental period of 90 days.

Treatment	Parameters		
	pH	Dissolved Oxygen (mg/L)	Temperature (°C)
T1	7.33±0.27[a]	7.33±0.28[b]	29.76±0.95[a]
T2	7.25±0.24[a]	7.30±0.26[c]	29.80±0.89[a]
T3	7.25±0.18[a]	7.33±0.26[bc]	29.88±0.87[a]
T4	7.27±0.14[a]	7.39±0.26[a]	29.80±0.85[a]
LSD (0.05)	0.30	0.030	1.22
Mean	7.22	7.33	29.81
F-Value	2.01	2.30	2.01
CV (%)	5.28	0.46	5.20

3.1 Temperature

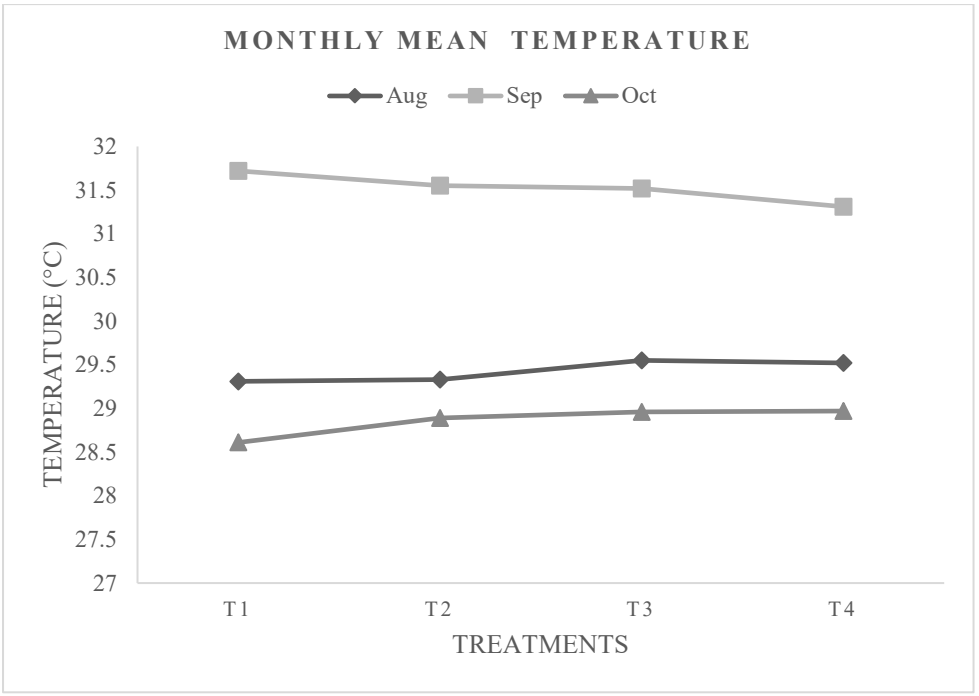

Figure 2: Monthly temperature variation during the experimental period of 90 days.

3.2 Dissolved oxygen (DO)

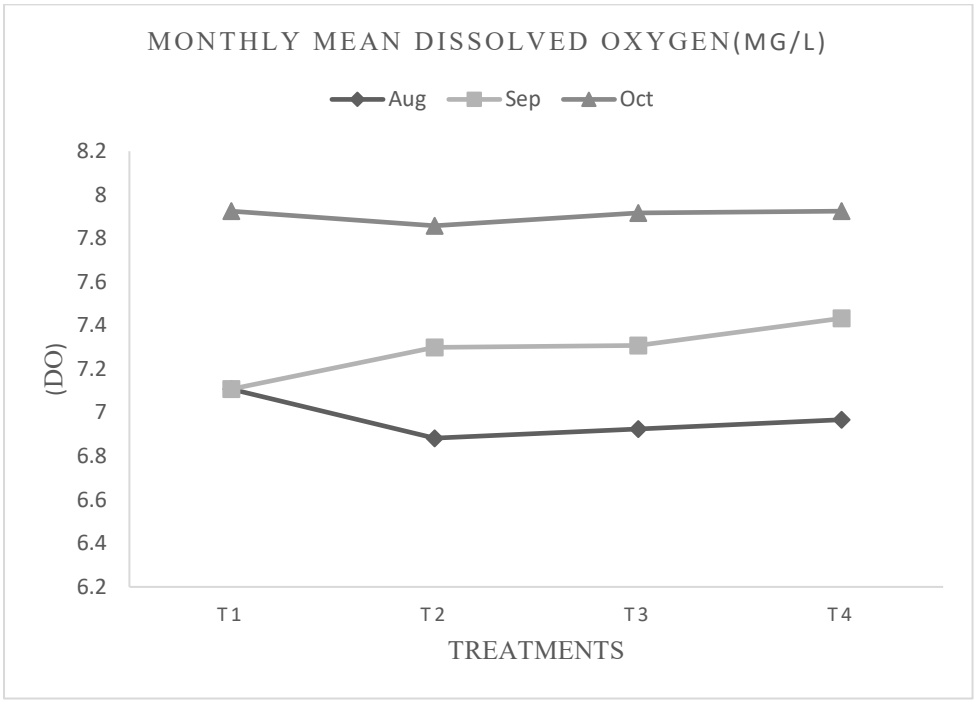

Figure 3: Monthly Dissolved Oxygen variation during the experimental period of 90 days.

3.3 Potential of Hydrogen (pH)

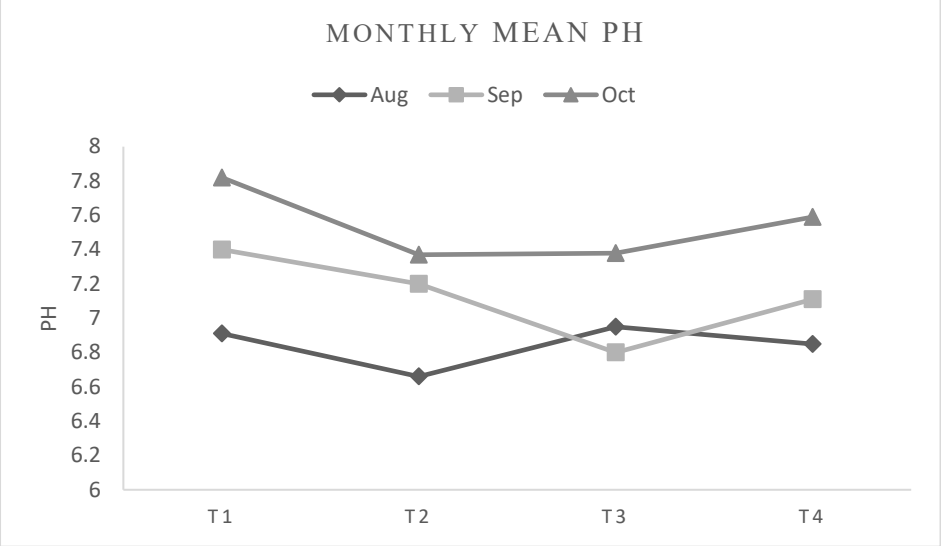

Figure 4: Monthly pH variation during the experimental period of 90 days.

4. Discussion

Highest mean weight gain was recorded in T3 (1.2±0.02g) ($p<0.05$). Comparatively, the daily weight gain of common carp was high in treatment three due to the better response of common carp to 15% water hyacinth supplemented diet used in rearing when compared to other diets. The poor weight gain in above 15% inclusion level may be because of high fiber level. According to the study for 90 days, common carp fed diet D5 (i.e., 16% of total feed, or 40% of RB replacement with fermented WH) showed notably high growth and enhanced flesh quality (Sadique et al., 2018).

The highest specific growth rate was recorded in T3 (1.4 ± 0.06 g) ($p < 0.05$). Make a note of the study: supplementation of water hyacinth as a fish feed ingredient showed a positive effect on the growth of grass carp. (*Ctenopharyngodon idella*) (Pratiwi and Andhikawati, 2021). The incorporated water hyacinth meal up to a 25% level did not negatively impact the mirror carp's ability to thrive. The results of mirror carp fed at 0%,15%, and 25% water hyacinth incorporation demonstrate a declining tendency as the amount of water hyacinth meal in the feed increased from 15% to 25%. (Sarker and Aziz, 2020). Suggested up to 20% inclusion fermented water hyacinth leaf meal in diets of Nile tilapia. Lowest FCR was recorded in T3 (2.14±0.115) ($p<0.05$) (Emshaw, 2023). Similar result regarding feed conversion ratio and growth parameters were obtained while using 15% water hyacinth in fish feed in the research conducted by (Sarker and Aziz, 2020). This suggests that rearing of common carp fry in cage by feeding 15% water hyacinth as fish feed is a profitable business.The gross return was found highest in T3 (58.95±2.30) and lowest T4(40.12±0.64) ($p<0.05$) while the net return was also highest in T3 (12.69±1.65) and lowest in T1 (2.43±1.34) ($p<0.05$). (Sadique et al., 2018). Suggests that rearing of common carp fry in cage by feeding 15% water hyacinth as fish feed is a profitable business. Highest BCR was recorded in T3 (1.27±0.01) ($p<0.05$) (Sarker and Aziz, 2020) suggested supplementation of water hyacinth up to an optimum level to produce cost effective feed for the growth performance of *Cyprinus carpio* (Mohapatra, 2015). During the experimental period of 90 days, the mean temperature was found to be 29.81 ºC. Similarly, mean dissolved oxygen was found to be 7.33 mg/l and the mean pH range was 7.22 during the experimental period. According to the research conducted condition of water quality parameters were similar to the result obtained from this result, namely the temperature 29.73-29.78 c by (Syafi'i, 2017). The dissolved oxygen was 6.11-6.73mg/l and the pH were 6.58 to 6.65.

The temperature ranged from 28.1 to 34.5 °C, the pH was approximately 8.0, and the dissolved oxygen fluctuated between 5.56 and 8.78 mg/L during the experiment (Sadique *et al*., 2018). According to the study, no significant difference was found for the mean values of all the water quality parameter with the temperature to be ranged from 20.5-36.5°C and the pH values ranging from 6.5 to 9.0 (Sarker and Aziz, 2020). This statement is agreed with the temperature to be ranged from 20.5-36.5°C (Ali *et al*., 1982). This statement is also more or less agreed with the temperature to be ranged found by other researchers (Alim, 2005; Chakraborty and Mirza, 2007). The trend of the dissolved oxygen level is in increasing order which is due to the decrease in the temperature of the water as the research progress as the dissolved oxygen of the water is inversely proportional to the water temperature. The increasing pH range as the research progress is due to the decrease in the temperature as the water temperature and pH are inversely proportional to each other.

5. Summary and Conclusion

During the experiment period, different growth rate was recorded in different treatment. The final mean weight of fish was highest in T3 (159.3±6.23 g) at ($p<0.05$). Similarly, the SGR value was highest (1.4±0.06g) in T3 while T4 (1.0±0.04 g) was found to be the lowest. The survivability was recorded in a range of (76.6-90).

Feed conversion ratio was recorded lowest in T3 ($p<0.05$). Similarly, highest BCR was recorded in T3 (1.27±0.01) which was significantly different with T1(0.94±0.02), T2(1.04±0.02) and T4(0.97±0.008) ($p<0.05$). The gross return was found highest in T3 (58.95±2.30) and lowest T4(40.12±0.64) ($p< 0.05$) while the net return was also highest in T3 (12.69±1.65) and lowest in T1 (2.43±1.34) ($p< 0.05$).

During the experimental period of 90 days, the mean temperature was found to be 29.81 ºC. On the initial day temperature was recorded 28.35°C. the temperature was seen increasing in the first two month and decreased in the third month. No significant difference ($p > 0.05$) was seen among all the treatments. Mean value of DO was range from 6.6 to 8.3 mg/L and range of DO 6.6-6.9 mg/L was recorded on the initial days of the research. Similarly, the pH range was 6.6-8.1 during the experimental period of 90 days. The range of DO 6.6-6.8 was recorded on the initial days of the research.

Based on the results, we recommend incorporating 15% water hyacinth powder as partial replacement for soyabean meal in common carp feed.

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