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Dietary Inclusion of Water Hyacinth (*Eichhornia crassipes*) Meal: Impacts on Growth Performance and Profitability in Broilers

Lalit Kumar[1], R. Zuyie[1], Sourav Barman[1], V. K. Vidyarthi[1], Rajan Singh[1], Sanjay[2] and Sonam Kumari Mina[3]

[1]Dept. of Livestock Production and Management, School of Agricultural Sciences, Nagaland University, Medziphema Campus, Nagaland (797 106), India

[2]Dept. of Livestock Production and Management, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan (334 006), India

[3]Dept. of Livestock Production and Management, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan (313 001), India

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Corresponding lalitbhaisahab@gmail.com

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ABSTRACT

The experiment was conducted during August–October, 2023 at the Poultry Unit, Nagaland University, India to evaluate the effect of dietary supplementation of water hyacinth (*Eichhornia crassipes*) meal on growth performance and economic efficiency of broiler chickens. A total of 160 day-old broiler chicks were reared for 42 days under standard management conditions and randomly allocated to four dietary treatments in a completely randomized design, with five replicates of eight birds each. They were maintained as per standard procedures. All birds were fed a starter diet from 0 to 21 days, followed by finisher diets supplemented with water hyacinth meal at 0, 25, 50, and 75 g kg^{-1} feed from 22 to 42 days. The collected data was subjected to one-way analysis of variance. The results indicated that birds receiving 25 g kg^{-1} supplementation showed significantly higher final body weight and improved weight gain during the fourth and fifth weeks, while feed conversion ratio remained comparable among treatments. No mortality was observed in this group, whereas minimal mortality occurred in others. Economic parameters, including net return and benefit–cost ratio, were also higher at this inclusion level. In conclusion, supplementation of water hyacinth meal at 25 g kg^{-1} in the finisher diet improved growth performance and profitability, suggesting its potential as a cost-effective alternative feed resource in broiler production.

KEYWORDS: Water hyacinth, feed utilization, broiler performance, mortality

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1. INTRODUCTION

Poultry production sciences are crucial in bolstering food security and addressing the increasing worldwide need for animal protein, while also promoting sustainability. Comprehending and utilizing consumer behaviors facilitates the creation of adaptable and sustainable production systems that can efficiently respond to societal changes and future market demands. (Nassar and Farid, 2026). With the expansion of production scale and the adoption of improved systems, the poultry sector now holds significant potential to contribute to rapid economic growth. According to the Anonymous (2019), the total poultry population in the country is 851.81 million, representing an increase of 16.81% over the previous census. Egg and broiler production have increased annually at a rate of 8–10%, whereas the output of most agricultural commodities has increased at a comparatively lower rate of 1.5–2% year^{-1}. India ranks second globally in egg production and fourth in total meat production, recording 10.50 mt during 2024–25. Poultry meat contributes approximately 49% in total meat production. A consistent increase in per capita egg availability has also been observed, rising from 79 eggs per year in 2018–19 to 106 eggs in 2024–25. Andhra Pradesh remains the largest egg-producing state, accounting for 18.37% of national egg production during 2024–2025. Despite the rapid growth of the poultry industry, escalating production costs continue to pose a major challenge to sustainable profitability. Feed costs constitute 68–75% of broiler production expenses and 75–80% of layer production expenses. The cost of feed is a significant factor in adjusting production expenses to enhance profitability (Bibyan, and Kour, 2024). The increased adoption of non-conventional feed resources may mitigate feed supply shortages, diminish competition for food between humans and cattle, reduce feed expenses, and improve nutrient self-sufficiency via locally sourced feed materials (Belay and Janssens, 2021). Employing cost-effective and accessible local feed resources could significantly enhance poultry productivity (Lukuyu et al., 2011).

Water hyacinth (*Eichhornia crassipes*) is a fast-growing invasive aquatic weed widely distributed across tropical regions (Adeyemi and Osubor, 2016). The plant proliferates rapidly, forming dense mats that obstruct waterways, disrupt aquatic ecosystems, reduce biodiversity and create favorable conditions for the spread of disease vectors (Simpson and Sanderson, 2002). Due to its rapid vegetative growth and long-term seed viability, the control and eradication of water hyacinth remain highly challenging. Since its introduction into Ethiopia in 1965, it has been identified as one of the most troublesome aquatic weeds, with subsequent infestation reported in Lake Tana in 2011 (Rezene, 2005; Tewabe, 2015). Despite its invasive nature, the substantial biomass produced by water hyacinth offers potential for productive utilization, particularly as a livestock feed resource (Jafari, 2010). Dietary fiber was often thought to be an antinutritional element, its potential advantages have led to an increase in interest in its utilization in poultry nutrition. Poultry diets that contain a suitable amount of dietary fiber improve growth performance, nutrient utilization, and gastrointestinal tract development, (Jha and Mishra, 2021). The crude protein content of water hyacinth meal varies considerably, with levels reaching up to 20% in leaves and about 10% in leaf sheaths, depending on plant part, processing technique, and environmental conditions (Alkassar and Al-Shukri, 2018; Moses et al., 2021). Although several studies have highlighted the nutritional potential of water hyacinth, comprehensive and systematic investigations regarding its dietary inclusion in poultry feeds, particularly for broiler chickens under Indian production conditions, remain limited. Therefore, the present study was undertaken to evaluate the effect of dietary supplementation of water hyacinth meal on growth performance and economic efficiency of broiler chickens.

2. MATERIALS AND METHODS

The experiment was conducted for a period of 42 days during (August 21, 2023 to October 2, 2023) at the Poultry Unit, Nagaland University, India. A total of 160 day-old broiler chicks were randomly allocated to four treatments (T_1–T_4) in a Completely Randomized Design, with five replicates of eight birds each. Birds were fed a starter diet (0–21 days) followed by a finisher diet (22–42 days). Water hyacinth meal was included at 0, 25, 50, and 75 g kg^{-1} feed in T_1, T_2, T_3, and T_4, respectively. Prior to the experiment, the brooder house and all equipment were thoroughly cleaned, disinfected, and whitewashed. The floor was treated with lime powder and covered with sawdust bedding (2–3 inches). Chicks were brooded under a deep litter system up to 21 days, with the temperature maintained at 37.5°C during the initial period. Birds were housed in separate compartments according to treatments to avoid positional bias and later shifted to cages after three weeks. A total of 160 day-old broiler chicks were randomly divided into four treatment groups (T_1–T_4), each comprising five replicates of eight birds. Birds were fed a commercial starter diet (0–1 days) followed by a finisher diet (22–42 days). Dietary treatments included: T_1 (basal diet), T_2 (25 g kg^{-1} water hyacinth meal), T_3 (50 g kg^{-1}) and T_4 (75 g kg^{-1}). Body weight was recorded at weekly intervals, initially on a group basis and later individually, using a digital weighing balance. Weekly body weight gain was calculated accordingly. Feed and water were provided *ad libitum*, and feed intake was determined by recording feed offered and residuals. Broiler performance efficiency index and economic parameters

were calculated following standard procedures (Narahari et al., 2000). Data were analyzed using one-way ANOVA under a Completely Randomized Design as described by Snedecor and Cochran (1998). All experimental procedures were conducted in accordance with standard animal care and management practices.

3. RESULTS AND DISCUSSION

3.1. Average body weight

The average initial body weight of day-old chicks ranged from 44.00 to 47.38 g across treatment groups, indicating uniformity at the start of the experiment. At six weeks of age, the final body weight was recorded as 2138.10, 2275.23, 2069.83, and 2131.80 g in T_1, T_2, T_3 and T_4, respectively, suggesting an influence of dietary treatments on growth performance. At the fourth week, birds in the control group (T_1) exhibited relatively higher body weight; however, during the fifth and sixth weeks, birds supplemented with 25 g kg^{-1} water hyacinth meal (T_2) showed superior body weight compared to other groups. This trend indicates that moderate inclusion of water hyacinth meal enhanced growth performance. The improvement might attributed to the presence of beneficial nutrients in water hyacinth. Conversely, higher inclusion levels (50 and 75 g kg^{-1}) resulted in comparatively lower body weight, possibly due to the presence of anti-nutritional factors such as tannins, which may impair nutrient digestibility and utilization (Alkassar and Al-Shukri, 2018).

The findings of the present study are in agreement with earlier reports by Suthama (2004) and Dumaup and Ampode (2020), who observed improved final body weight in broiler chickens fed diets containing 5% and 2.5% water hyacinth, respectively. Suthama (2004) further attributed the improvement in body weight to enhanced protein digestibility, nitrogen retention and metabolizable energy due to the inclusion of water hyacinth leaf protein concentrate in broiler diets. Additionally, several studies have reported the high nutritive value of water hyacinth meal and supported its potential use as a cost-effective feed ingredient in poultry diets (Adeyemi and Osubor, 2016; Nandiyanto, 2023).

3.2. Body weight gain

The average body weight gain during the first week ranged from 146.25 to 153.03 g $bird^{-1}$across treatment groups, indicating comparable early growth. At the sixth week, body weight gain was recorded as 496.65, 548.58, 474.03, and 481.73 g $bird^{-1}$ in T_1, T_2, T_3 and T_4, respectively. The overall mean body weight gain during the experimental period was highest in T_2 (377.98 g), followed by T_1 (352.35 g), T_4 (347.82 g), and T_3 (340.89 g). Dietary supplementation of water hyacinth meal influenced body weight gain, particularly during the fourth and fifth weeks. Birds in T_2 (25 g kg^{-1}) consistently exhibited higher weight gain compared to other groups, whereas variations among T_1, T_3 and T_4 remained minimal. In the sixth week, differences among treatments were comparatively small, although T_2 maintained numerically higher gains. Consistent with the present results, several researchers including Alkassar and Al-Shukri, (2018) they reported that there was significant differences (p<0.05) among treatments in weight gain of broiler chicken and that the level of 5% WHM replacement by wheat gave excellent results.

3.3. Feed intake and feed conversion ratio

At six weeks of age, birds in treatment group T_2 recorded the highest feed intake (980.68 g), followed by T_4 (917.55 g), T_1 (911.15 g), and T_3 (903.10 g), with relatively minor variation among the latter groups. The increased feed intake in T_2 may be attributed to improved palatability and the appealing aroma and flavor of diets supplemented with water hyacinth meal, as reported by Dumaup and Ampode (2020) and Keak et al. (2022). Similar findings were observed by Malik et al. (2016), who reported higher feed intake in broilers fed diets containing water hyacinth meal compared to the control group. Despite differences in feed intake, feed conversion ratio remained comparable across all treatment groups. Mustari et al. (2025), who reported no significant differences in FCR during the initial stages of supplementation with water hyacinth meal at 2.5% of the diet, although improvements were observed at later stages. The increased feed intake and body weight gain observed in the present study were not sufficient to produce significant differences in feed conversion efficiency.

3.4. Feed conversion ratio

The feed conversion ratio (FCR) at six weeks of age was 1.84, 1.81, 1.93 and 1.91 in T_1, T_2, T_3 and T_4, respectively. The overall mean FCR for the entire experimental period was 1.53 (T_1), 1.50 (T_2), 1.53 (T_3) and 1.55 (T_4). Although dietary inclusion of water hyacinth meal showed some influence on FCR during the fourth week, the values remained statistically comparable among treatments during the fifth and sixth weeks. However, birds receiving 25 g kg^{-1} supplementation (T_2) exhibited numerically improved feed efficiency. The present results were in agreement with Ampode et al. (2020) in poultry production, feed conversion ratio (FCR) plays a vital role in measuring broilers performance. FCR is a rate measuring the efficiency with which the bodies of livestock convert animal feed into the desired output, which means that the lower the value, the more efficient the birds are in converting feed to live weight. Overall, the findings indicate that incorporation of water hyacinth meal at the tested levels does not adversely affect feed conversion efficiency in broiler chickens

3.5. Mortality, livability and broiler performance efficiency index

Mortality, livability, and broiler performance efficiency index (BPEI) were presented in Table 1. No mortality was recorded in T_2, whereas a mortality rate of 2.5% was observed in T_1, T_3 and T_4. Accordingly, livability was 100% in T_2 and 97.5% in the remaining groups. The overall low mortality across treatments indicates good health status of the birds, likely due to quality chicks, proper management, and favorable environmental conditions. These results suggest that dietary inclusion of water hyacinth meal did not adversely affect survivability. Enhanced immune status, particularly improved bursal development, may have also contributed to better livability, as reported by Dumaup and Ampode (2020). The BPEI values were 136.02, 151.68, 131.78 and 134.08 for T_1, T_2, T_3 and T_4, respectively. Birds in T_2 (25 g kg^{-1}) exhibited the highest BPEI, indicating superior overall performance efficiency, followed by T_1, T_4 and T_3. Since BPEI values above 100 were considered indicative of efficient and profitable production, the results demonstrate that moderate inclusion of water hyacinth meal enhanced performance without compromising bird health or survivability.

Table 1: Production performance of broiler chicken with the supplemented water hyacinth on the different group of treatment

Parameter		Treatments			
	Week	T_1	T_2	T_3	T_4
Body wt (g $birds^{-1}$ wk^{-1})	onset	44.00	47.38	44.48	44.48
	6th	2138.10[b]	2275.23[a]	2069.83[b]	2131.80[b]
	Mean	1094.10	1120.04	1031.06	1060.26
	Total	6564.60	6720.25	6186.35	6361.58
Gain in body wt (g $birds^{-1}$ wk^{-1})	1st	151.75	148.25	153.03	146.25
	6th	496.65	548.58	474.03	481.73
	Mean	352.35	377.98	340.89	347.82
	Total	2114.10	2267.85	2045.35	2086.93
Feed intake (g $birds^{-1}$ wk^{-1})	1st	136.88	139.85	137.03	140.38
	6th	911.15[b]	980.68[a]	903.10[b]	917.55[b]
	Mean	573.44	599.88	558.60	572.89
	Total	3440.65	3599.25	3351.63	3437.35
FCR	1st	0.90	0.94	0.90	0.96
	6th	1.84	1.81	1.93	1.91
	Mean	1.53	1.50	1.53	1.55
	Total	9.20	8.98	9.21	9.31
Liveability (%)	6th	97.50	100	97.50	97.50
Performance index	6th	136.19[b]	151.68[a]	131.78[b]	134.08[b]
Mortality (%)	6th	2.5	0	2.5	2.5

a,b, Means bearing different superscripts in a column differ significantly (p<0.05)

3.6. Economics

Economics of production performance of broiler chicken was presented in Table 2. The cost of production $bird^{-1}$ was highest in T_2 (₹ 265.44) and lowest in T_3 ₹ 252.03). However, the cost of production kg^{-1} of live weight was lowest in T_2 (₹ 122.31) and highest in T_4 (₹ 125.51). Net profit $bird^{-1}$ (₹ 75.81) and kg^{-1} of live weight (₹ 27.69) were also highest in T_2, while comparatively lower values were observed in T_3 and T_4. Similarly, the benefit–cost ratio was superior in T_2 (1.37) compared to other treatment groups. The results indicate that dietary supplementation of water hyacinth meal at 25 g kg^{-1} feed resulted in improved economic returns. The enhanced profitability in T_2 might attributed to higher body weight, better feed efficiency, and improved broiler performance efficiency index. These findings were consistent with previous studies reporting improved economic outcomes with inclusion of unconventional feed resources such as water hyacinth and Azolla (Dumaup and Ampode, 2020; Kamel and Hamed,

Table 2: Effect of water hyacinth on the economics of broiler production

Items	Treatment groups			
	T_1	T_2	T_3	T_4
Cost of chicks (₹ bird^{-1})	59.85	59.85	59.85	59.85
Feed conversion ratio	1.53	1.50	1.53	1.55
Final body weight (kg)	2.138	2.275	2.070	2.132
Cost of feed (₹ bird^{-1})	170.40	177.15	165.17	172.06
Miscellaneous cost (₹ bird^{-1})	27.63	28.44	27.00	27.83
Cost of production bird (₹ bird^{-1})	257.88	265.44	252.03	259.74
Cost of production kg broiler (₹ kg^{-1})	124.37	122.31	124.49	125.51
Receipt through sale of broiler birds at 150 kg^{-1} live weight	320.70	342.25	310.50	319.80
Profit bird (₹)	62.82	75.81	58.47	60.06
Net profit kg^{-1} live weight (₹)	25.63	27.69	25.51	24.49
Benefit cost ratio	1.33	1.37	1.31	1.31

1 US$=INR 82.23 (Average monthly values for October, 2023)

2021; Fahmi et al., 2024). Overall, water hyacinth meal could considered a viable and cost–effective alternative feed ingredient for broiler production.

4. CONCLUSION

Dietary inclusion of water hyacinth meal at 25 g kg^{-1} feed (T_2) improved growth performance of broiler chickens, with higher final body weight and enhanced body weight gain. Feed intake was also higher, while feed conversion ratio remained comparable. Improved livability with no mortality observed, indicated no adverse health effect. Economic analysis revealed profitability, with lower cost per unit live weight. In conclusion, incorporation of water hyacinth meal at 25 g kg^{-1} feed in broiler diets was recommended.

5. ACKNOWLEDGEMENT

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