Effect of Inclusion of Different Levels of Duckweed (Lemna minor) on the Performance of Broiler Chicken

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Effect of Inclusion of Different Levels of Duckweed (*Lemna minor*) on the Performance of Broiler Chicken

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ABSTRACT

Background: Duckweed is a monocotyledon species of the family *Lemnaceae*. It is a small floating aquatic plant that grows very well on stagnant ponds and is commonly found throughout tropical countries in natural ponds, lakes and flooded rice fields. Duckweed has high crude protein content and a well-balanced amino acid profile and is also a good source of vitamins and minerals. Duckweed at different levels was utilized in the diet of broiler chicken to study their performance.

Methods: One hundred and fifty day old broiler chicks of one week old were distributed randomly into five treatment groups *viz* T_1: (Control), T_2: 5% Duckweed without enzyme, T_3: 5% Duckweed with enzyme, T_4 :10% Duckweed without enzyme and T_5 :10% Duckweed with enzyme having 30 chicks in each groups with three replicates of 10 chicks each.

Results: The Duckweed contains 20.33% crude protein, 3.10% ether extract, 18.06% crude fibre, 2.80% calcium, 1.10% phosphorous and 1660.77 ME (Kcal/ Kg). Significantly ($P \leq 0.05$) higher body weight was recorded in T_1 (1889.67±13.28g) and T_3 (1878.65±2.02g) groups followed by T_2 (1831.67±3.51g), T_5 (1798.31±1.76 g) and T_4 (1728.63±2.60 g) groups, respectively. The average daily body weight gain was ranged between 37.87 to 41.66 g. The cumulative feed consumption was recorded to be highest in T_1 (3050.13±14.01) and lowest in T_4 (2943.17±8.54g) group. The Cumulative FCR was significantly ($P \leq 0.05$) better (1.74±0.01) in T_1 and T_3 groups in comparison to T_2 (1.78±0.01), T_4 (1.85± 0.01) and T_5 (1.78± 0.04) groups. Total 3.3% mortality was recorded in all treatment groups except T_3 group in which there was no mortality during entire experimental period.

Key words: Duckweed, Bodyweight, Feed Consumption, Feed conversion ratio, Broiler chicken,

INTRODUCTION

The Indian poultry sector has evolved into a vibrant agribusiness spurred by domestic economic growth and consumption dynamics. The sector has been growing at around 8-12% annually over the last decade with annual growth rates of 8.51 percent and 11.44 percent in egg and broiler production, respectively driven by increased domestic consumption (BAHS, 2019). The revolution of Indian poultry sector is contributing to improved nutrition and poverty reduction. Today India is the sixth largest producer of poultry meat in the world with an annual production of 4.06 million MT and third largest producer of eggs with an annual production of 103.32 billion (BAHS, 2019). In poultry rearing, feed cost accounts for 60-70% of the total cost of production.There is a shortage of quality feed ingredients in Kashmir valley. The cost of feed is higher in Kashmir valley compared to other parts of the country because of additional transportation cost incurred during importation from neighbouring states. Inclusion of non conventional feed resources in poultry ration such as aquatic macrophytes like Duckweed (DW) could be one of alternatives which may reduce the cost of poultry production in Kashmir Valley.

Duckweed (*Lemna minor*) is a monocotyledon species of the family *Lemnaceae* adapted to grow in water at temperatures between 6 and 33°C (Leng *et al.* 1995). It can be grown to recycle nutrients from waste water and it provides a good source of proteins and can be utilized for the production of some products such as animal feed and fuel ethanol (Cheng and Stomp, 2009). This plant grows rapidly and gives high yields with high protein content, low fibre content and high mineral content.

The potential nutritional value of Duckweed in broiler chickens has been recognized (Haustein *et al.* 1994). The Duckweed plant has been postulated to offer a solution to the feeding of broiler chickens (Khandaker *et al.* 2007). This plant has been used to replace protein sources such as sesame oil cake (Ahammad *et al.* 2003) and fishmeal (Effiong *et al.* 2009) at graded levels. In this regard, it is important to determine how important the Duckweed is in the nutrition of broiler chickens under temperate climate.

Many trials have been carried out using Duckweed as the major feed to raise fish, pig, chicken and also ducks. Duckweed has high crude protein content and a well-

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balanced amino acid profile and is also a good source of vitamins and minerals for livestock (Men *et al.* 2001). Even though the moisture content of duckweed can be the first limiting factor for chickens, it can play important role in poultry feeding. It contains 28% crude protein, 3.7% crude fat, 33.8% ash, 11.5% fibre and 42.6% carbohydrates (Tania *et al*. 2009).

Despite many studies conducted on utilization of Duckweed as a feed ingredient in broilers ration, probably no systematic study on their effect is carried out in Kashmir valley, although it is abundantly available in the water bodies of this region. Therefore, the present experiment has been undertaken to study the performance of broiler chicken fed different levels of Duckweed with or without enzyme supplementation.

MATERIALS AND METHODS

The present study was conducted during March to August, 2019 at Experimental Poultry Farm, Division of Livestock Production and Management, Faculty of Veterinary Sciences and Animal Husbandry, SKUAST Kashmir, Jammu and Kashmir, India. The Duckweed was collected from the local water bodies of Srinagar district. The material was transported to the Poultry Farm. The material was dried properly and stored for future use. All together ten types of experimental diets (five Starter and five Finisher) were prepared on iso-nitrogenous and iso-caloric basis as per BIS (1992) using Duckweed at different levels of with or without enzyme supplementation *viz*. T_1 (Control) group: basal diet only prepared without Duckweed, T_2 group: Basal diet replaced with 5% Duckweed without enzyme, T_3 group: Basal diet replaced with 5% Duckweed with enzyme, T_4 group: Basal diet replaced with 10% Duckweed without enzyme and T_5 group: Basal diet replaced with 10% Duckweed with enzyme. 150 broiler chicks were procured from reputed source (Private Company) and brooded in battery cages. On 8th day 150 chicks were distributed into five treatment groups *viz*. T_1, T_2, T_3, T_4 and T_5 containing 30 chicks in each which were subdivided into three replicates of 10 chicks each. The birds were offered *ad lib.* measured quantity of experimental diets twice daily. The birds were reared under deep litter system for a period of six weeks.

The proximate analysis of Duckweed was carried out as per the method of AOAC (1990). The calcium and phosphorus were estimated as per the method of Talapatra *et al.* (1940). The metabolizable energy (Kcal/Kg) of DW was calculated as per the formula of Pauzenga (1985).

The weekly body weight, weekly feed consumption and cumulative feed consumption, mortality were recorded for all the treatment groups. The body weight of the experimental birds was recorded on individual basis at weekly intervals. The feed consumption was recorded on group basis at weekly intervals. From recorded data body weight gain, feed conversion ratio, daily protein intake, protein efficiency ratio etc. was calculated. The data obtained were analysed as per the method of Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Chemical composition of Duckweed

The chemical composition of Duckweed has been presented in Table 1. However, higher crude protein value was reported by Tania *et al.* (2009). In contrary to the findings of present study the lower values of crude fibre was also reported (Kabir *et al.* 2005; Khanum *et al.* 2005; Khandaker *et al.* 2007). It contains 2.80% calcium and 1.10% phosphorous. The ME (Kcal/kg) calculated out in the present study was much lower than the value reported (Khanum *et al.* 2005; Iram *et al.* 2015). The variation in nutrients reported by different authors may be due to the more availability of nutrients in the aquatic environment where they have been grown.

Body Weight

The mean body weight of control group (T_1) and 5% DW with enzyme supplementation (T3) was significantly ($P \leq 0.05$) higher than other groups during 4th and 5th weeks. Similar trends in body weights were also noticed at 6th week of age with significant ($P \leq 0.05$) differences in the final body weight (Table 2) being highest in T_1 group (1889.67±13.28 g) and lowest in T_4 group (1728.63±2.60 g). Reduced growth of broilers with increasing level of Duckweed in the diet might be due to high fibre content of Duckweed which increased the bulkiness of feed and lower digestibility of protein in Duckweed supplemented diets (Islam *et al.* 1997). However, enzyme supplementation improved the body weight in the present study. The body weight of broiler chicken was reduced significantly ($P \leq 0.05$) at 6th week when Duckweed at 12% level was incorporated in the diet (Kabir *et al.* 2005). The body weight of broiler linearly declined as the proportion of Duckweed meal in the diet was increased (Islam *et al.* 1997; Kabir *et al.* 2005; Iram *et al.* 2015). Increase in body weight with the supplementation of enzyme in the diet of broilers has been observed in the present study supported by other workers (Bansal *et al.* 2012).

However, in contrary to the present study, Kusina *et al.* (1999) found that incorporation of Duckweed in broiler finisher diets up to 10% levels did not affect the growth

Table 1: Proximate composition of Duckweed.

Attributes	Mean ± SE
Dry matter (%)	89.85±1.25
Moisture (%)	10.15±0.48
Crude protein (%)	20.33±0.65
Ether extract (%)	3.10±0.12
Crude fibre (%)	18.06±0.86
Total ash (%)	30.35±0.58
Acid Insoluble Ash (%)	7.00±0.24
Nitrogen Free Extract (%)	18.52±0.28
Calcium (%)	2.80±0.08
Phosphorus (%)	1.10±0.06
Tannins (%)	-
Phytins (%)	0.93±0.02
Metabolizable Energy (Kcal/ kg)	1660.77

performance of birds. Haustein *et al.* (1994) recorded significantly ($P \leq 0.05$) higher live weights in broilers fed a diet containing 5% levels of Duckweed compared to other treatments which were fed higher or lower levels of Duckweed.

Body Weight Gain

The overall mean body weight gain (g) from 1-6 weeks of age was significantly ($P \leq 0.05$) higher in T1 (Control) and T3 groups than T_2, T_4 and T_5 groups (Table 3). The lower body weight gain in the groups fed with Duckweed might be due to high fibre content of Duckweed, increases the bulkiness of feed and lower digestibility of protein. Significantly lower body weight gain was also recorded by Ahammad *et al.* (2003) in broilers and Khandaker *et al.* (2007) in Jinding ducks when the diet was replaced by Duckweed at different levels. The body weight gain significantly ($P \leq 0.05$) decreased as the level of Duckweed was increased in the diet of broiler chicken (Islam *et al.* 1997; Kabir *et al.* 2005). However, enzyme supplementation significantly ($P \leq 0.05$) improved body weight gain by improving the digestibility of feed and thereby better absorption and assimilation of the nutrients available resulting in higher body weight gain. The effect of enzyme supplementation on body weight gain in broilers in the present study was supported by the findings of Mathlouthi *et al.* (2003), Luo *et al.* (2009) and Tiwari *et al.* (2010).

However, in contrary to present study, higher body weight gain in chicks fed Duckweed compared with chicks fed diets without Duckweed was reported (Khang and Ogle, 2003). The average body weight gain of ducks was significantly ($P \leq 0.05$) lower in control diet as compared to Duckweed diets (Khanum *et al.* 2005).

The average daily body weight gain was highest during 4-5 week ranged between 53.18 g in T4 to 57.44 g in T1 groups and lowest during 1-2 week ranged between 32.93 g in T4 to 33.62 g in T1 groups as the T1group does not supplemented with Duckweed resulting no viscosity. The average daily body weight gain was decreased as the level of Duckweed increased in the diet. However, enzyme supplementation compensates the body weight gain. The total average daily body weight gain was ranged between 37.87 to 41.66 g during 1-6 weeks of age.

Feed Consumption

The cumulative feed consumption of T4 and T5 group was found to be significantly ($P \leq 0.05$) lower than T1, T2 and T3 groups (Table 4). The reduced feed consumption in Duckweed supplemented group might be due to increased level of fibre content and bulkiness of diet. The decreased feed consumption was due to fishy smell, unpalatibility, voluminous and dustiness of the feed on increasing dietary level of Duckweed meal (Kabir *et al.* 2005). The decreased feed consumption with incorporation of Duckweed in the diet of broilers was reported by many workers (Akter *et al.* 2011; Iram *et al.* 2015).

Table 2: Weekly Mean Body weight (g) in broiler chicken fed Duckweed with or without enzyme supplementation.

Age in weeks	T1(Control)	T2(5%DW)	T3(5%DW+Enzyme)	T4(10%DW)	T5(10%DW+Enzyme)
1	139.34±2.72	138.65±1.45	138.36±1.20	137.83±1.30	137.68±0.33
2	374.34±1.20	370.21±1.15	371.66±2.02	368.34±3.38	369.67±2.72
3	698.33^{d}±3.78	688.67^{c}±1.45	690.33^{c}±2.33	668.67^{a}±1.45	679.33^{b}±2.60
4	1096.67^{d}±4.48	1072.33^{c}±5.23	1088.67^{d}±1.45	1036.34^{a}±3.48	1048.67^{b}±0.88
5	1498.69^{d}±11.25	1457.66^{c}±2.84	1486.35^{d}±2.33	1408.65^{a}±4.67	1428.08^{b}±4.65
6	1889.67^{d}±13.28	1831.67^{c}±3.51	1878.65^{d}±2.02	1728.63^{a}±2.60	1798.31^{b}±1.76

Means across rows bearing different superscripts differ significantly ($P \leq 0.05$).

Table 3: Weekly mean Body weight gain (g) in broiler chicken fed Duckweed with or without enzyme supplementation

Age in Weeks	T1(Control)	T2(5% DW)	T3 (5%DW +ENZYME)	T4(10% DW)	T5(10%DW+ENZYME)
1-2	235.33±3.78	231.33±1.20	233.34±3.17	230.50±2.59	232.11±2.51
	(33.62)	(33.04)	(33.33)	(32.93)	(33.16)
2-3	324.09^{c}±4.61	318.66^{bc}±2.60	318.67^{bc}±1.76	300.35^{a}±3.28	309.68^{b}±0.67
	(46.29)	(45.52)	(45.52)	(42.90)	(44.24)
3-4	398.66^{c}±2.40	383.66^{b}±6.56	398.05^{c}±3.28	367.64^{a}±3.33	369.36^{a}±2.18
	(56.95)	(54.80)	(56.86)	(52.52)	(52.76)
4-5	402.11^{b}±13.20	385.33^{ab}±7.53	398.89^{ab}±1.66	372.31^{a}±8.08	380.11^{ab}±3.78
	(57.44)	(55.04)	(56.98)	(53.18)	(54.30)
5-6	391.11^{b}±15.70	374.12^{b}±2.08	392.31^{b}±0.33	320.15^{a}±7.23	369.67^{b}±6.35
	(55.87)	(53.44)	(56.04)	(45.73)	(52.81)
1-6	1750.12^{d}±13.19	1693.11^{c}±3.51	1740.34^{d}±2.18	1590.83^{a}±3.89	1660.69^{b}±2.02
	(41.66)	(40.71)	(41.44)	(37.87)	(39.54)

Means across rows bearing different superscripts differ significantly ($P \leq 0.05$).

Figures in the parenthesis indicates average body weight gain per day per bird.

However, enzyme supplementation non significantly increased feed consumption in the present study which might be due to increased digestibility of nutrients in enzyme supplemented diets. The birds fed on enzyme supplemented diets consumed more when compared to control group (Khan and Siddique, 2006; Hajati *et al.* 2009). Ghobadi and Karimi (2012) also recorded significantly (P≤0.05) increased feed intake in broilers in wheat based diets when supplemented with enzyme.

The average daily feed consumption was ranged between 70.07 g in T_4 to 72.62 g in T_1 groups. The average daily protein intake was ranged between 15.06 g in T_3 to 15.65 g in T_1 groups. The protein efficiency ratio (PER) was ranged between 2.51 in T_4 to 2.66 in T_1 groups. The average daily feed consumption, average daily protein intake and protein efficiency ratio was decreased linearly as the level of Duckweed increased in the diet. However, enzyme supplementation improved the average daily feed consumption, average daily protein intake and protein efficiency ratio.

Feed Conversion Ratio (FCR)

The FCR of broiler chickens fed different levels of Duckweed with or without enzyme supplementation is presented in Table 5. The FCR during 1-2, 2-3 and 3-4 week of age did not differ significantly among different groups. However, the FCR was significantly (P≤0.05) poor in T_4 group as compared to other groups during 4-5 and 5-6 weeks of age.

The cumulative FCR was significantly (P≤0.05) improved in T_1 and T_3 groups in comparison to T_2, T_4 and T_5 groups. The lower FCR in Duckweed fed groups might be due to high level of fibre content of the diet which increases bulkiness resulting in reduced digestibility and ultimately decreased FCR. The lower FCR may also be due to lower body weight gain recorded in this study.

The feed efficiency decreased with the increase in proportion of Duckweed in the diet of broilers (Kabir *et al.* 2005). Ahammad *et al.* (2003) reported that the FCR was improved when Sesame oil cake was replaced by Duckweed at 3% and 6% level but the FCR was poorest at 9% Duckweed.

The improvement in FCR by enzyme supplementation in the present study was in accordance with the findings of Hajati *et al.* (2009) and Luo *et al.* (2009) who also reported improved in FCR with enzyme supplementation in the diet of broilers as the supplementation of enzyme is capable of breaking down the non starch polysaccharides and phytates and thereby enhancing the nutrient availability to the birds results in improved FCR.

Mortality

The mortality was recorded in different groups up to 3^{rd} weeks of age, after that no mortality was recorded in any of the treatment groups. The total mortality of 3.3% was recorded in all treatment groups except T_3 group in which no mortality was recorded. The main cause of mortality as per post mortem report was Colibacillosis and Salmonellosis which might be carried by drinking water as the birds were provided untreated spring water. The mortality was not affected by incorporation of Duckweed in the diet of broiler chicken

Table 4: Feed consumption (g) and Protein efficiency ratio in broiler chicken fed Duckweed with or without enzyme supplementation.

Age (Weeks)	T1(Control)	T2 (5%DW)	T3 (5%DW+Enzyme)	T4 (10% DW)	T5(10% DW + Enzyme)
1-2	326.66±2.40	319.64±3.75	321.65±2.02	318.66±2.02	320.61±2.40
2-3	458.33^c±1.20	452.64^c±1.85	458.61^c±2.96	431.67^a±0.66	440.32^b±0.88
3-4	602.65^c±4.80	587.12^b±1.73	594.32^b±1.85	560.65^a±5.78	564.12^a±2.30
4-5	784.10^b±4.16	788.12^b±2.08	789.13^b±2.30	784.12^b±2.64	764.11^a±3.05
5-6	878.31^b±4.40	868.68^b±5.96	876.65^b±2.40	848.11^a±1.15	872.66^b±1.76
1-6	3050.13^c±14.01	3017.11^b±10.58	3040.33^{bc}±3.66	2943.17^a±8.54	2961.66^a±4.84
Average daily feed consumption (g)	72.62	71.80	72.38	70.07	70.51
Daily protein intake (g)	15.65	15.51	15.64	15.06	15.15
Protein efficiency ratio (PER)	2.66	2.62	2.65	2.51	2.60

Means across rows bearing different superscripts differ significantly (P≤0.05).

Table 5: Weekly and Cumulative feed conversion ratio in broiler chicken fed Duckweed with or without enzyme supplementation.

Age (Weeks)	T1(Contol)	T2(5%DW)	T3(5%DW+Enzyme)	T4(10% DW)	T5(10% DW + Enzyme)
1-2	1.39±0.02	1.38±0.01	1.37±0.01	1.38±0.01	1.38±0.01
2-3	1.41±0.01	1.42±0.01	1.43±0.02	1.43±0.01	1.42±0.01
3-4	1.51±0.01	1.53±0.03	1.49±0.01	1.52±0.02	1.52±0.02
4-5	1.95^a±0.07	2.04^{ab}±0.03	1.98^{ab}±0.01	2.10^b±0.04	2.01^{ab}±0.01
5-6	2.25^a±0.07	2.32^a±0.02	2.23^a±0.01	2.65^b±0.06	2.36^a±0.03
1-6	1.74^a±0.01	1.78^b±0.01	1.74^a±0.01	1.85^c±0.01	1.78^b±0.04

Means across rows bearing different superscripts differ significantly (P≤0.05).

evidenced by the histomorphology of liver of broiler chicken which did not show any variation from normal structure indicating no adverse effect of feeding Duckweed in broilers. Kabir *et al.* (2005) also reported that incorporation of Duckweed did not affect the mortality which is in support of the present experiment.

CONCLUSION

Duckweed is a very good source of crude protein, calcium and phosphorus. It could be used as alternative source of feed ingredients in the diet of broiler chicken for reducing the feed cost. High fibre content and bulkiness of the Duckweed often limits its use at higher level. From the present investigation it is evident that Duckweed could be included in the diet of broiler chicken at 5% level with enzyme supplementation for better performance without any adverse effects.

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