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PN Shinde
M.Sc. Student, Department of Animal Husbandry and Dairy Science, Dr. B. S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, Dist. Ratnagiri, Maharashtra, India

NN Prasade
Assistant Professor, Department of Animal Husbandry and Dairy Science, Dr. B. S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, Dist. - Ratnagiri, Maharashtra, India

Shalu Kumar
Ph.D. Scholar, Department of Animal Husbandry and Dairy Science, Dr. B. S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, Dist. - Ratnagiri, Maharashtra, India

BG Desai
Head, Department of Animal Husbandry and Dairy Science, Dr. B. S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, Dist. - Ratnagiri, Maharashtra, India

JS Dhekale
Associate Professor, Department of Agricultural Economics and Statistics, Dr. B. S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, Dist. - Ratnagiri, Maharashtra, India

VS Dandekar
Associate Professor, Department of Animal Husbandry and Dairy Science, Dr. B. S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, Dist.- Ratnagiri, Maharashtra, India

RG Burte
Dean, College of Agriculture Dapoli, Dr. B. S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, Dist. Ratnagiri, Maharashtra, India

DJ Bhgat
Associate Professor, Department of Animal Husbandry and Dairy Science, Dr. B. S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, Dist.- Ratnagiri, Maharashtra, India

Correspondence
Shalu Kumar
Ph.D. Scholar, Department of Animal Husbandry and Dairy Science, Dr. B. S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli, Dist. - Ratnagiri, Maharashtra, India

Chemical composition of *Azolla (Azolla pinnata)* and their exploring effects on the production performance of broilers

PN Shinde, NN Prasade, Shalu Kumar, BG Desai, JS Dhekale, VS Dandekar, RG Burte and DJ Bhgat

Abstract
An experiment was conducted at Poultry unit, Dept. of Animal Husbandry and Dairy Science, Dr. B.S. Konkan Krishi Vidyapeeth Dapoli, Maharashtra to assess the chemical composition of *Azolla pinnata* and their effect on the performance of broilers. A total 120 chicks (144) were reared together until 9 days of age in brooding stage. On 10th day, the chicks were weighed individually and distributed randomly into four dietary groups with five replications and each replication have six chicks. A control diet (T_0) containing 0.0 % *Azolla* and three experimental diets in which *Azolla* was partially (5%; T_1), (10%; T_2) and T_3 replaced (15%) by *Azolla* (*Azolla pinnata*) were prepared. An average body weight of 2344.20, 2507.37, 2285.50 and 2244.03 g was found in groups T_0, T_1, T_2 and T_3 respectively at the end of 6th week. The feed conversion ratio significantly superior found T_1 (1.70) followed by T_0 (1.81), T_2 (1.82) and T_3 (1.84), respectively. Supplementation of *Azolla* at the rate of 5% for 42 days showed the significant increase *($P<0.05$)* in dressing percentage. There was no adverse effect on the performance of broiler chicken when 5% of broiler diet was replaced with *Azolla*. Hence, net profit per bird was maximum achieved in T_1 (Rs.61.91) followed by T_3 (Rs. 51.54), T_2 (Rs. 49.58) and T_0 (Rs. 47.09), respectively. The study concluded that supplementation of *Azolla* meal at the rate of 5 % in broiler diet for 42 days increased body weight gain and meat quality. Therefore, it can be used as a poultry feed to reduce feed cost and profitable broiler farming.

Keywords: *Azolla*, *Azolla pinnata*, Chemical composition, broilers, experimental

1. Introduction
Although the poultry industry in India has made remarkable progress during last 3 decades, yet the escalating cost and unavailability of the feed ingredients are the major deterrent for target production. Feed is the most expensive of all inputs and about 70 per cent of production cost is accounted for feed alone [1]. As feed related improvement in the performance has a profound effect on profitably, the poultry nutritionists have been trying to find out alternative cost effective, non-conventional feed ingredients. Aquatic plant species, because of their growth habit, appear not to accumulate secondary plant compounds and therefore offer a greater potential than tree leaves as a source of protein for monogastric animals [2].

Azolla is a small aquatic fern which flows on the water surface. The name is referred to conjugation of two Greek words, azo (to dry) and allyo (to kill) because the fern is killed by drought. Use of *Azolla* was initially limited as green manure but its use as mosquito inhibitor herbicide, water saver, water purifier, nitrogen fertilizer saver [3], as drug, for reclaiming saline soils [4] and as bioremediation [5, 6] are also been investigated. *Azolla* hosts symbiotic blue-green algae, *Anabaena Azollae*, which is responsible for the fixation and assimilation of atmospheric nitrogen. *Azolla*, in turn, provides the carbon source and favorable environment for the growth and development of the algae. It is this unique symbiotic relationship that makes *Azolla*, a wonderful plant with high protein content [6].

Considering its nutrient content [7, 8], *Azolla* was started to be used as feed ingredients for poultry, pig and livestock species. Though variable results were observed, most of the researches suggested improvement on production and reproduction parameters in poultry bird when birds were fed with *Azolla* meal replacing basal diets upto a certain level. For determine the potential of using *Azolla* meal as a partial replacement of broiler diet, current study was designed to observe effect of feeding different levels of *Azolla pinnata* on growth and economic returns of broilers.

2. Materials and Methods

2.1 Experimental design, housing and management

In the experiment, there were four dietary treatment groups each with five replications and each replication have six birds. The first treatment (T_0) served as control in which basal diets was offered without *Azolla* supplementation while in T_1, T_2 and T_3 groups basal diet was replaced with *Azolla* meal at 5 %, 10 %, and 15 % levels, respectively. For experimental feeding trial, 120 days old broiler chicks (*Vencobb*) were procured from M/S Venkateshwara Hatcheries Pvt. Ltd., Pune and reared for 7 weeks. Chicks were kept on deep litter system in brooder house under standard managemental and hygienic conditions for 9 days and temperature was regulated to 30 to 35^0C. They were provided standard broiler starter ration on newspaper spread on the floor. After 9 days, chicks were individually weighed and randomly divided into four groups of 30 chicks each, on the basis of average uniform body weights, discarding the extreme ranges of body weights. The chicks were transferred replicate wise (6 birds) in the compartments of similar dimensions. The chicks were housed in deep litter system. All the housing and managemental conditions were similar for different treatment groups. Fresh and clean water was provided *ad libitum* to the chicks of different treatment groups. Throughout the experimental period, the chicks were provided artificial light by electric bulbs of sufficient intensity.

2.2 Feeds and feeding schedule

Standard broiler feeds for starter (0-4 weeks) and finisher (4-8 weeks) periods as per [9] were provided. The composition of feeds for the starter and finisher periods are presented in Table-1. In the treatment group, calculated amount of *Azolla* replaced basal diets at different levels. *Azolla* was collected from Livestock Instructional Unit of Department of Animal Husbandry and Dairy Science, Dr. B.S. Konkan Krishi Vidyapeeth (Agricultural University) Dapoli and then it was dried under the sun for 10-15 minute. Feed was offered daily to the birds at 8.00 A.M. Representative samples of *Azolla pinnata* powder and experimental feed of starter and finisher was analyzed for their nutrient composition *viz*. dry matter (DM), crude protein (CP), ether extract (EE), total ash and crude fiber (CF), as per [10].

2.3 Data collection and statically analysis

The data on feed consumption, body weight and feed conversion efficiency were collected at weekly interval. At the end of experiment the one bird per replication randomly selected and kept separately and fasted for a period of 12 hours. Prior to their slaughter the live weight of the birds were recorded. After removal of feathers and complete bleeding, the dressed yield of each bird was recorded. The complete digestive tract, legs and head were removed to calculate edible carcass yield of individual bird. Heart, liver, and gizzard were also weighed individually and the average yield of each of these organs was recorded for the respective groups. The percentage of dressed yield, edible carcass yield and weight of different organs were calculated over live weights. Dressing percentage was calculated as per the following formula: *Dressing percentage = Dressed meat weight/ Live weight × 10* and data were subsequently analysed statistically by following completely randomized design [11] to record the effect of feeding AZM in broilers.

3. Results and Discussion

3.1 Chemical composition of experimental diet

The chemical composition of *Azolla* meal and experimental diet is given in Table-2. The proximate principles, *i.e.*, DM, CP, CF, EE, nitrogen free extract (NFE) and total ash of *Azolla* meal were found to be 89.91 %, 21.56 %, 3.37 %, 43.69%, 15.05% and 16.33%, respectively. The chemical composition of *Azolla* was comparable with the previous observations of different scientists [12, 13, 14, 15, 6]. The dry matter of *Azolla* was 89.91per cent. The result are almost similar with earlier observation of [16, 17, 18]. Similar to our findings, the CP content of *Azolla* meal was reported in the range of 21.4-25.57 % [3, 12, 19]. In contrary to this, [17] obtained lower CP content of 16.5-17.67 per cent in *Azolla* meal. However, higher CP content (25.69%) observed by [15] as compared to present study. The 15.05% crude fiber obtained in the present study is slightly higher than the findings of [1] and [15] who reported the CF content of *Azolla* in the range of 13.19-16.54 per cent and 15.91 per cent CF in *Azolla* and lower CF (14.60%) was recorded by [14]. The EE content of *Azolla* in the present study (3.37%) is almost similar to the earlier observed [14] and [15]. Both scientists found similar results of EE content of 3.39% in *Azolla* meal. The NFE content of 43.69% recorded in this study was higher than the value reported by [1] and [15] as 38.85-39.13% NFE in *Azolla*. Total ash content of *Azolla* obtained in this experiment was 16.33%. Similar, value of Ash was recorded by [15], who reported that 15.88 per cent ash content in *Azolla* meal. [17] also reported a very high value of 36.12% ash in *Azolla*. However, other workers [7] recorded values almost similar to the present study. The variations in the nutrient composition of *Azolla* meal in different studies could be attributed to differences in the response of *Azolla* strains to environmental conditions such as temperature, light intensity, and soil nutrients which consequently affect their growth morphology and composition. Moreover, species difference of *Azolla* could alter their nutrient composition. Furthermore, contamination with epiphytic algae could also be important to such a degree as to affect the results of chemical composition [28].

3.2 Performance parameters of birds

The performance parameters viz., average body weight gain (ABWG), weekly body weight gain (WBWG), feed conversion ratio (FCR) mortality rate are presented in Table 2.

3.2.1 Body weight gain (g)

The body weight gain was found to be highest in T_1 followed by T_0, T_2 and T_3, respectively (Table 2). The body weight gain was significantly ($P<0.05$) lower in T_3 groups in comparison to T_0 groups which might be due to the presence of higher level of crude fibre in AZM. In this experiment, the diet containing of 5% level of *Azolla* meal was best in respect of body weight (2464.46g) while control diet was second the best (2298.49 g) in 6 weeks of age. So use of higher level of *Azolla* meal may had deleterious effect on body weight as in T_3 (15%). The higher level of *Azolla* (T_2 and T_3) meal resulted poor growth than T_1 and T_0 treatments. This might be due to higher level of NDF in *Azolla* meal is the main limiting factor for efficient utilization in monogastic animals [20]. [21] reported higher lignin *i.e.*, 17.48% might cause poorer growth as against the diet containing 10 and 15 per cent *Azolla* meal. Contrary to the present observation, [8] did not find change in

body weight up to the level of 4.5 per cent incorporation of AZM in broiler diet.

3.2.2 Feed consumption (g/bird)

In the present study feed consumption was significantly higher in T_1 (4343.83 g) experimental group, results indicating that inclusion of *Azolla* affect the feed consumption up to 5 per cent level. Similar findings were reported earlier by [22] and [23]. They found that the inclusion of *Azolla* in broiler diet affect feed consumption upto 15%. But [24] stated that *Azolla* affected the palatability of the feed and reduced feed consumption.

3.2.3 Feed conversion ratio (FCR)

The FCR was comparable among T_0, T_2 and T_3 groups; however, T_1 group had significantly *(P<0.05)* superior FCR value. Higher level of crude fibre and tannins in aquatic plants might be responsible for decreased nutrient utilization leading to wider feed conversion ratio [25]. Feed conversion ratios decreased significantly at 10 and 15% *Azolla* meal in the diet. Similar findings were reported by [15] who recorded FCR (1.88) after inclusion of 5 per cent *Azolla* in broiler diet. However, contrary to the present finding [26] did not observe change in feed efficiency with 5 per cent level of incorporation of AZM in broiler diets.

3.2.4 Survivability rate

Treatment group (T_1) not any bird died during the experimental period. So, survivability was cent per cent in 5% dietary treatment group. This indicates that *Azolla* meal had no any deleterious effects on broilers. The results are similar with [22] and [27] who also found no toxic effect of dietary *Azolla* on broiler.

3.3 Effect of *Azolla* feeding on broilers production

Except feed cost, other cost was constant and feed cost was only factor that differed the total production cost of broiler. The total cost per broiler was highest in T_0 (159.31 Rs./kg live broiler) and gradually lower in T_1 (Rs. 158.94), T_2 (Rs. 152.57) and T_3 (Rs. 146.36) dietary treatments (Table 4). As the *Azolla* is an unconventional feed and the price per kg was lower than commercial broiler ratio and that is why the feed cost and total production cost per broiler was highest in the T_0 group and the cost gradually lower in the other treatment groups for the same reason. Total cost per broiler was highest in T_0 but the profit per broiler highest in T_1. The main cause of highest profit in T_1 groups were body weight of broilers. In the present study net profit per bird was highest in T_1 group followed by T_3, T_2 and T_0 groups, respectively; however, profit per kg live weight gain was maximum achieved in T_1 group as compared to T_0 group. The finding of present study agreement with [15] who recorded highest profit of per bird supplemented by 5 per cent *Azolla* meal.

4. Conclusion

Azolla is a good source of protein and it can be used upto 5% level in the broiler diet for better performance and carcass quality. *Azolla* meal had no deleterious effect on palatability of the diets. *Azolla* meal is an unconventional feed ingredients at low price and can be used as a poultry feed to reduce feed cost and profitable broiler farming.

Table 1: Nutrient contents of experimental diet (g/kg as DM).

Proximate principle	Broiler starter	Broiler finisher	*Azolla* meal
Dry matter	91.24	88.96	89.91
Crude protein (CP)	21.28	19.34	21.56
Ether extract (EE)	4.56	4.73	3.37
Crude fibre (CF)	6.59	5.63	15.05
Nitrogen free extract (NFE)	65.65	68.55	43.69
Total ash	1.92	1.75	16.33

Table 2: Performance of broilers on feeding different levels of *Azolla* meal.

Attribute	Treatments				S.E.±	C.D. at 5%
	T_0 (0.0% AMZ)	T_1 (5 % AMZ)	T_2 (10 % AMZ)	T_3 (15 % AMZ)		
DOC weight (g)	45.7	45.3	45.7	45.8	-	-
Avg. body wt. gain (g)	2344.20^b	2507.37^a	2285.50^b	2244.03^c	10.40	32.05
Final body wt. gain (g)	2298.49^b	2464.46^a	2239.81^b	2198.16^b	46.43	143.09
Weekly body wt. gain (g)	383.08^b	410.74^a	373.30^b	366.36^b	7.74	23.85
Feed consumption (g/bird)	4281.54^b	4343.83^a	4259.03^b	4236.04^c	107.79	N.S.
FCR	1.81^b	1.70^a	1.82^b	1.84^b	0.03	0.09
Mortality rate	3/30	0/30	1/30	2/30	-	-
Survivability (%)	90.00	100.00	96.66	93.33		

Table 3: Effect of *Azolla* supplementation on the broiler production.

Particulars	Treatments			
A. Variable cost	T_0 (0.0% AMZ)	T_1 (5 % AMZ)	T_2 (10 % AMZ)	T_3 (15 % AMZ)
Price of day old chicks (Rs.)	20	20	20	20
Total feed consumption /bird (kg)	4.21	4.34	4.25	4.24
Cost of *Azolla* (Rs. 10/kg)	-	2.06	3.86	5.53
Average *Azolla* meal consumption /bird (g)	-	206.69	386.4	553.05
Average basal feed consumption /bird (kg)	4.21	4.13	3.86	3.60
Cost of starter and finisher (Rs. 30.3 /kg)	127.56	125.13	116.96	109.08
Total cost of feed (Rs.)	127.56	127.19	120.82	114.61

Misc. expenditure (Medicine, water & labour charges etc.) (Rs.).	9.0	9.0	9.0	9.0
B. Fixed cost				
Depreciation on building and implements	1.25	1.25	1.25	1.25
Interest on FC (10% of fixed investment)	1.50	1.50	1.50	1.50
Total fixed cost (B)	2.75	2.75	2.75	2.75
Total cost (A+B) (Rs.)	159.31	158.94	152.57	146.36
Sales return				
Average body weight gain (kg)	2.34	2.51	2.29	2.24
Sale price / bird **(**Rs.85/kg live wt.)	198.9	213.35	194.65	190.4
Poultry manure (Rs. 3/kg)	7.50	7.50	7.50	7.50
Total return (Rs.)	206.4	220.85	202.15	197.9
Net profit/bird (Rs.)	47.09	61.91	49.58	51.54
Per kg profit (Rs.)	20.12	24.66	21.65	23.00
Benefit: cost (B:C) ratio	1.29	1.38	1.32	1.35

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