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Performance of Coloured Synthetic Broiler Chicken Fed Dried Azolla as Protein Substitute

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A B S T R A C T

The study was carried out to evaluate the growth performance of colour synthetic broiler chicken fed with sun dried *Azolla* as protein substitute. The 150 day-old broiler chicks of either sex were distributed randomly in five dietary treatments with 3 replicates each, C1: basal diet, T1: basal diet + 10% dietary protein from Azolla, T2: basal diet + 10% dietary protein from Azolla + enzyme, T3: basal diet+ 15% dietary protein from Azolla, T4: basal diet + 15% dietary protein from *Azolla* + enzyme. The experiment was carried out for 92 days for evaluating performance with respect to body weight, body weight gain, feed consumption, feed conversion ratio (FCR), and economics of production. Each of the Azolla fed group, compared to control, showed significantly ($P \leq 0.05$) higher body weight. T4 showed higher gains than T1 till 4th week whereas no significant ($P \geq 0.05$) difference was recorded between the Azolla fed groups from 5th week onwards. Azolla fed group registered significantly ($P \leq 0.05$) higher consumptions than the control from 2nd week. However between the two non-enzymes groups T1 showed higher ($P \leq 0.05$) values than T3. Enzyme supplementation resulted in a lower consumption in 10% Azolla group while it led to a higher consumption in 15% Azolla group, and that between the two enzyme groups, group T4 showed higher values ($P \leq 0.05$) than group T2. Throughout the experiment feed efficiency of Azolla fed group showed higher than the control. Cost benefit analysis on basis of net return/bird or net return/kg live weight, each of Azolla fed groups showed higher economic efficiency than the control. It was concluded that Azolla could be included in the broiler ration up to 15% level which resulted in higher body weight gain and feed efficiency. It leads to substantial economisation of feed cost of production.

Introduction

Poultry is one of the fastest growing segments of the agricultural sector in India today. The growth of country's poultry sector is however, confronted with a major stumbling block- scarcity and high price of feed ingredients. Since feed cost alone accounts for 60-70% of total production cost Bhuiyan *et al.,* (1998), it is essential that all possible efforts be made for lowering feed cost for a sustainable and rewarding poultry enterprise. The shrinking resources of world grain production and its escalating cost has triggered a search for cheap unconventional feeds for poultry production Shamna *et al.,* (2013). Aquatic plant species have been observed to be a fairly cheap feedstuff for poultry and can partly substitute the conventional and expensive dietary protein sources Haustein *et al.*, (1994). Of the various species, the cosmopolitan fern Azolla is perhaps the most promising from the point of view of ease of cultivation, productivity and nutritive value Becerra *et al.*, (1995). Azolla is very rich in proteins, essential amino acids, chlorophyll, vitamins (vitamin A, vitamin B12 and Beta-Carotene), growth promoter intermediaries and minerals like calcium, phosphorous, potassium, ferrous, copper, magnesium etc. Azolla could replace 20-25% of commercial feed and exhibits excellent results in poultry (Subudhi and Singh, 1978). Hence, the proposed study is undertaken to explore the potential effect of supplementation of Azolla on the performance of coloured synthetic broiler birds in terms of body weight gain, feed efficiency, and cost efficiency of production.

Materials and Methods

The 150 day-old colour synthetic broiler chicks of either sex belonging to a single hatch were procured from poultry farm, College of Veterinary Science & Animal husbandry and reared in Instructional Livestock Farm in deep litter system of rearing and were distributed randomly in five dietary treatments with 3 replicates each, C1: basal diet, T1: basal diet + 10% dietary protein from Azolla, T2: basal diet + 10% dietary protein from Azolla + enzyme, T3: basal diet+ 15% dietary protein from Azolla, T4: basal diet + 15% dietary protein from *Azolla* + enzyme. For the preparation of experimental diets, Azolla was cultivated in Instructional Livestock Farm, Orissa University of Agriculture and Technology, Bhubaneswar as per the standard procedures Pillai *et al.,* (2002) with slight modification. The diets were made isocaloric and isonitrogenous. The ingredient compositions of the broiler starter and broiler finisher rations, nutrient compositions of the broiler starter and finisher rations are presented in Tables 1 and 2 respectively.

The chemical composition such as DM, CP, ether extract, crude fiber, NFE, total ash and acid insoluble ash, of Azolla samples were analysed as per AOAC (1995). Determination of calcium was done as the method modified by Talapatra *et al.,* (1940). The micro minerals viz. zinc, copper, manganese and iron contents in the samples were estimated in atomic absorption spectrophotometer (ELECO-246®). The day old chicks were wing banded for identification. The chicks were brooded by electric brooder with hover for one week. All the chicks were vaccinated against Ranikhet Disease (Lasota strain) on 7^{th} day, Infectious Bursal Disease (Intermediate strain) on 14^{th} day and Ranikhet Disease vaccine (Lasota strain) booster on 28^{th} day. The weekly feed intake and body weight was recorded.

Recording of body weight

Body weight of 1^{st} week and thereafter at weekly intervals up to 7^{th} week was recorded. The body weight gain was calculated by subtracting the initial body weight from final body weight of the periods and cumulative gains for successive weeks were calculated.

Feed consumption and feed conversion ratio (FCR)

The group average feed consumption was calculated by subtracting the residual feeds at the end of each week from the total feed provided to the birds during the said weeks. Cumulative feed consumption was calculated by adding from 1^{st} week feed consumption up to the desired week. Feed conversation ratio was derived by dividing cumulative feed consumption up to a particular week with cumulative body gain up to that week.

$$\text{FCR} = \frac{\text{Cumulative feed consumption (g) up to a particular week}}{\text{Cumulative body weight gain (g) up to that week}}$$

Economics of broiler production

The cost of different diet used in the study was worked out based on the prevailing prices of the constituent feed ingredients, minerals, salts and other additives including that of enzymes. The differences in returns between groups were ascribed only to the costs of the diets. The relative cost effectiveness of each diet was thus assessed. The calculated costs of feed for the treatment groups are presented in Table 3 and 4.

Statistical analysis

The statistical analysis of the data was done according to the method described by (Snedecor and Cochran, 1998). Charts and calculations were done with the help of Data analysis tool of Office 2007.

Chemical composition of Azolla meal

The chemical analysis of ground dried Azolla used in experimental rations is presented in Table 5.

Weekly body weight and body weight gain

The average body weights and average cumulative weight gains for the birds at weekly interval up to 7th week of age in different treatment groups are presented in Table 6. No significant ($P \geq 0.05$) difference in body weight was observed till the end of 2nd week, while significant ($P \leq 0.05$) differences were observed between groups from 3rd week onwards.

Azolla fed group, showed significantly ($P \leq 0.05$) higher body weight compared to control from 3rd to 7th week.

The highest and lowest cumulative gains at the end of both starter phase (3rd week) and finisher phase (7th week) were shown by treatments T4 and C1, respectively. While no difference ($P \geq 0.05$) was noticed between the groups in 2nd week. However significant ($P \geq 0.05$) differences were observed between groups from 3rd week onwards.

Azolla fed group, in comparison to the control, registered higher ($P \leq 0.05$) weight gains in every week from 3rd to 7th week, except in 7th week when groups C1 and T1 had no significant ($P \geq 0.05$) differences. From these findings it may be interpreted that, Azolla, which is rich in crude protein and contains a high metabolizable energy (ME) level, might have improved digestion and also, might have increased the availability of dietary nutrients as reported by several authors Subudhi and Singh, (1978), Cambel, (1984), Querubin *et al.*,(1986), Sarria and Preston, (1995), (Basak *et al.*, 2002), Seth *et al.*, (2014), Chichilichi *et al.*, (2014)

Body weights or body weight gains for the enzyme supplemented group, T2 and T4 were not significantly ($p \geq 0.05$) different from T1 and T3, respectively. However numerically higher body weights and weight gains were recorded for groups T2 and T4 in all age groups. This implied that enzyme supplementation with both 10% and 15% levels of Azolla inclusion in the diet improved the growth rate of birds. This might be due to improved digestibility of feed due to enzyme supplementation Rajeshwara and Devegowda, (1996) and Choct *et al.*, (1995) stated that suitable enzyme combination strategies from different feed ingredients might result in an increase in feed intake, stimulation of growth and improvement of feed conversion.

Feed consumption

The cumulative weekly feed consumptions, for the birds in different dietary treatments, are presented in Table 7. Each of the Azolla fed group registered significantly ($P \leq 0.05$) higher consumptions than the control from the 2nd week continuing till the end of the experiment Differences ($p \leq 0.05$) were also recorded between the Azolla fed groups except in the 2nd week.

In the non-enzyme groups, in the present study, inclusion of Azolla at 10% level resulted in increase in feed consumption compared to the controls. This corroborated the findings of Cambel (1984) who reported highest feed intake in 10% Azolla meal fed broilers compared to 0, 5, 10, 15, 20 or 25% Azolla meal fed groups. Seth *et al.,* (2014) also reported numerically higher consumption at 10% than at 15% Azolla inclusion level.

The findings in the present study are at variance with those of Querubin *et al.,* (1986) who reported consistent increase in feed intake when Azolla meal was fed at 0, 5, 10, 15% level.

These differences in the findings between the present study and the other ones might be attributed to chicken types used with varying capacities of fibre degradation along with environmental factors. In the enzyme supplemented groups, in the present study, the 15% Azolla group (T4) showed higher consumptions than the 10% group (T2).

These findings are in the line of those reported by Querubin, (1986), Sarria and preston (1995) and 13. Parthasarathy *et al.,* (2002) even though these authors did not use enzyme. Chennegowda *et al.,* (2001) observed that enzyme preparations (xylanase and pectinase or xylanase and cellulase) improved digestibility of NSPs by enzyme supplementation only at sufficient levels of substrate (20% SFE) as feed enzyme had higher Km. Hence Azolla at 10% level might have been an adequate substrate for the enzyme action.

In the 15% Azolla groups the enzyme group (T4) showing higher consumptions than the non-enzyme group (T3) might be attributed to the significantly ($p \leq 0.05$) higher body weights (5th and 6th week) attained by the enzyme group (T4) with commensurate higher feed consumptions. Another reason could be that the enzyme level might have been inadequate leading to incomplete fibre degradation resulting in lower release of energy, thereby causing increased feed consumption

Feed conversion ratio (FCR)

The cumulative weekly FCR values, for the birds in the five groups, are also presented in the Table 7. There was no significant ($p \geq 0.05$) difference between the groups in the 2nd week. In the 3rd and 4th weeks, each of the Azolla fed groups showed significantly ($p \leq 0.05$) lower values than the control.

In the 5th week, the Azolla fed groups except group T1, showed lower ($p \leq 0.05$) values than the control (C1), there being no difference ($p \geq 0.05$) between groups C1 and T1. In 6th week, no significant ($p \leq 0.05$) difference was noticed between the groups, but in 7th week, significantly ($p \leq 0.05$) lower values in each of Azolla fed groups, as compared to control were observed.

Between the Azolla fed groups, no significant ($p \geq 0.05$) difference was recorded, except in the 3rd week, when group T4 showed a lower value ($p \leq 0.05$) than group T1 without any difference ($p \geq 0.05$) with any of the other two groups.

Table.1 Ingredient composition of broiler starter and broiler finisher ration

Ingredients	Broiler Starter					Broiler Finisher				
	C_1	T_1	T_2	T_3	T_4	C_1	T_1	T_2	T_3	T_4
Maize	55.0	50.3	50.3	46.4	46.4	60.0	57.25	57.25	42.4	42.4
Soya bean Meal	39.5	36.0	36.0	34.2	34.2	31.0	28.0	28.0	27.3	27.3
Deoiled Rice bran	2.5	0.0	0.0	0.0	0.0	5.25	2.0	2.0	0.5	0.5
Oil	0.0	1.5	1.5	2.8	2.8	0.75	1.75	1.75	3.0	3.0
Azolla	0.0	9.2	9.2	13.6	13.6	0.0	8.0	8.0	12.0	12.0
Mineral mixture and Common Salt	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Total	100	100	100	100	100	100	100	100	100	100
Enzyme (K zyme)	-	-	+	-	+	-	-	+	-	+

Table.2 Nutrient composition of experimental broiler starter and broiler finisher ration

Nutrient	Broiler Starter			Broiler Finisher		
	C_1	T_1/T_2	T_3/T_4	C_1	T_1/T_2	T_3/T_4
	Percentage on dry matter basis			Percentage on dry matter basis		
Moisture	11.0	12.2	12.8	13.14	12.90	13.25
Crude protein	23.17	23.15	22.78	20.14	20.12	20.01
Ether Extract	1.05	1.42	1.60	1.57	1.78	2.03
Crude fibre	4.01	4.63	4.92	4.03	4.30	4.89
Total Ash	6.34	7.48	7.97	6.37	7.20	7.87
Nitrogen free extract	65.43	63.32	62.73	67.89	66.60	65.20
Calcium	0.92	1.08	1.14	0.82	0.91	0.91
Available Phosphorus	0.48	0.51	0.50	0.53	0.51	0.54
Metabolisable energy*(Kcal/kg)	2800.50	2809.26	2805.00	2900.00	2902.21	2902.00

*Calculated value

Table.3 Calculated feed costs of starter rations

Ingredient	Cost/kg (Rs)	C_1	T_1	T_2	T_3	T_4
Maize	18	990	905.4	905.4	835.2	835.2
Soya	45	1777.5	1620	1620	1539	1539
Dorb	10	25	0	0	0	0
Oil	60	0	90	90	168	168
Azolla	1	0	9.2	9.2	13.6	13.6
Mineral Mix	60	120	120	120	120	120
Salt	10	10	10	10	10	10
TOTAL/100 Kg		2922.5	2769.6	2769.6	2713.8	2713.8
Enzyme @ 50g/100kg feed	300	0	0	15	0	15
Total cost including enzyme cost		2922.5	2769.6	2784.6	2713.8	2728.8
Feed cost/kg		29.22	27.69	27.84	27.13	27.28

Table.4 Calculated feed costs of finisher rations

Ingredient	Cost/ kg(Rs)	C_1	T_1	T_2	T_3	T_4
Maize	18	1080	1030.5	1030.5	763.2	763.2
Soya	45	1395	1260	1260	1228.5	1228.5
Dorb	10	52.5	20	20	5	5
Oil	60	45	105	105	180	180
Azolla	1	0	8	8	12	12
Mineral Mix	60	120	120	120	120	120
Salt	10	10	10	10	10	10
cost/100 kg		2710.0	2571.0	2571.0	2348.7	2348.7
Enzyme @ 50g/100kg feed	300	0	0	15	0	15
Total cost including enzyme cost		2710	2571	2586	2348	2363
Feed cost/kg		27.10	25.71	25.86	23.48	23.63

Table.5 Chemical composition of *Azolla* meal (D.M basis)

Nutrients	Percentage	Nutrients	Percentage
Dry matter	91.07	Calcium	1.10
Crude protein	25.40	Phosphorus	0.55
Crude fibre	14.23	Zinc (ppm)	158.6
Ether extract	2.58	Copper (ppm)	7.33
Total ash	18.76	Manganese (ppm)	83.92
NFE	39.03	Iron (ppm)	283.3

Table.6 Average weekly body weight (g) of broilers and absolute gains (g) of broilers

Age in Week	Body Weight(g)					P Value	Absolute gains(g)					P Value
	C_1	T_1	T_2	T_3	T_4		C_1	T_1	T_2	T_3	T_4	
1st	64.73± 0.58	65.80± 2.00	65.43± 0.47	64.76± 1.21	65.56± 1.78	1.00	-	-	-	-	-	-
2nd	97.83± 1.76	98.43± 1.95	98.26± 2.31	97.96± 1.68	98.40± 1.85	0.99	33.10± 0.75	32.56± 0.51	33.33± 2.42	33.03± 1.59	33.30± 1.36	0.99
3rd	133.83^{c} ±3.73	195.10^{b} ±5.20	195.90^{b} ±6.05	213.10^{a} ±6.92	228.00^{a} ±6.80	0.00	69.21^{d} ±3.93	130.40^{c} ±2.51	130.97^{c} ±2.18	147.67^{b} ±4.04	162.90^{a} ±5.49	0.00
4th	329.86^{c} ±12.40	530.07^{b} ±14.76	568.38^{a} ^{b}±16.32	568.72^{a} ^{b}±17.95	612.93^{a} ±17.14	0.00	265.19 ^{c}±27.94	464.85^{b} ±9.69	504.24^{a} ^{b}±13.23	502.67^{a} ^{b}±21.48	548.02^{a} ±1.45	0.00
5th	616.00^{c} ±15.17	848.97^{b} ±14.48	880.32^{b} ±18.50	882.17^{b} ±18.08	935.82^{a} ±19.22	0.00	553.06 ^{b}±28.79	783.67^{a} ±12.81	814.68^{a} ±12.91	815.57^{a} ±24.63	846.31^{a} ±37.80	0.00
6th	952.21^{c} ±26.45	1131.0^{b} ±25.77	1161.0^{b} ±37.17	1163.3^{b} ±32.98	1237.2^{a} ±34.4	0.00	891.17 ^{b}±63.97	1063^{a}± 43.14	1095.1^{a} ±14.26	1095.4^{a} ±45.52	1184.9^{a} ±34.23	0.00
7th	1215.10 ^{b}±25.36	1360.5^{a} ±36.88	1379.8^{a} ±36.03	1377.7^{a} ±37.03	1433.1^{a} ±17.84	0.00	1154^{b} ±31.69	1294.2^{a} ^{b}±40.27	1313.9^{a} ±63.41	1314.0^{a} ±17.83	1376.8^{a} ±62.10	0.065

Values bearing different superscripts in a row differ significantly ($P<0.05$)

Table.7 Cumulative weekly feed consumption (g) and feed conversion ratio (FCR) of broilers

Age	Feed consumption					P Value	FCR					P Value
	C_1	T_1	T_2	T_3	T_4		C_1	T_1	T_2	T_3	T_4	
2nd week	$157.17^b \pm 1.09$	$160.33^a \pm 0.88$	$160.33^a \pm 0.33$	$160.50^a \pm 0.28$	$160.83^a \pm 0.06$	0.025	4.75± 0.07	4.77± 0.04	4.86± 0.36	4.88± 0.23	4.84± 0.19	0.99
3rd week	$338.20^d \pm 1.67$	$391.50^b \pm 0.86$	$389.00^b \pm 1.15$	$384.27^c \pm 0.89$	$403.33^a \pm 1.45$	0.00	$4.92^a \pm 0.31$	$3.00^b \pm 0.06$	$2.97^{bc} \pm 0.04$	$2.60^{bc} \pm 0.06$	$2.48^c \pm 0.08$	0.00
4th week	$701.97^d \pm 2.32$	$1021.7^b \pm 1.76$	$1013.3.00^c \pm 3.33$	$1002.1^c \pm 9.13$	$1037.0^a \pm .3.60$	0.00	$2.70^a \pm 0.29$	$2.19^b \pm 0.04$	$2.01^b \pm 0.04$	$2.00^b \pm 0.10$	$1.89^b \pm 0.00$	0.01
5th week	$1315.5^d \pm 26.42$	$1744.1^b \pm 2.83$	$1669.5^c \pm 1.75$	$1704.3^c \pm 3.12$	$1799.8^a \pm 2.16$	0.00	$2.38^a \pm 0.09$	$2.22^{ab} \pm 0.03$	$2.05^b \pm 0.03$	$2.09^b \pm .06$	$2.13^b \pm 0.09$	0.04
6th week	$2146.7^c \pm 64.37$	$2476.7^b \pm 3.33$	$2385.2^b \pm 17.63$	$2445.2^b \pm 4.46$	$2582.0^a \pm 9.16$	0.00	2.42± 0.11	2.33± 0.09	2.17± 0.04	2.24± 0.09	2.18± 0.06	0.25
7th week	$3023.3^c \pm 92.43$	$3270.0.0^a \pm 10.00$	$3160.0^b \pm 10.00$	$3217.0^b \pm 12.99$	$3396.7^a \pm 16.66$	0.001	$2.61^a \pm 0.01$	$2.53^b \pm 0.08$	$2.41^b \pm 0.11$	$2.44^b \pm 0.02$	$2.47^b \pm 0.09$	0.04

Values bearing different superscripts in a row differ significantly ($P<0.05$)

Table.8 Economics of broiler production

Economics	Components	Groups				
		C_1	T_1	T_2	T_3	T_4
Expenditure /per bird	a. Cost of starter ration (Rs/kg)	29.22	27.69	27.84	27.13	27.28
	b. Cost of finisher ration (Rs/kg)	27.10	25.71	25.86	23.48	23.63
	c. Feed consumed in starter phase (g)	428.20	481.50	479.18	474.26	493.33
	d. Feed consumed in finisher phase (g)	2685.13	2878.5	2771.0	2833.4	2993.33
	e. Feed cost in starter phase (Rs)	12.51	13.33	13.33	12.87	13.46
	f. Feed cost in finisher phase (Rs)	72.76	74.00	71.65	66.54	70.75
	g. Total feed cost (Rs) (e + f)	85.28	87.34	84.99	79.41	84.21
Return /bird	h. Live weight (g) in 7 weeks	1215.10	1360.50	1379.80	1377.70	1433.10
	i. Receipt / bird @ Rs 78/kg live weight (Rs)	94.77	106.11	107.62	107.46	11.78
	j. Net return / bird (i - g) (Rs)	9.49	18.77	22.62	28.04	27.56
	k. Difference in net return over control	0	9.28	13.13	18.54	18.06
Return/kg live weight	l. Cost of feed consumed (Rs)	70.18	64.19	61.60	57.64	58.76
	m. Receipt per kg live wt. (Rs)	78	78	78	78	78
	n. Net return/ kg live weight (Rs) (m-l)	7.82	13.81	16.40	20.36	19.24
	o. difference in net return over control	0	5.99	8.59	12.54	11.42

The beneficial effects of dietary Azolla on FCR, as observed in the present study, corroborate those reported by several authors Basak *et al.,* (2002) found increased efficiency at 10%, (Dhumal *et al.,* 2009) at 2.5 to 5% level, (Seth *et al.,* 2014) at 5 to 15% level, and (Chichilichi *et al.,* 2014) at 5% levels of Azolla in the diet of chicken. Enzyme supplementation in the present study on 10% Azolla inclusion resulted in non-significantly ($p \geq 0.05$) better feed efficiency, while on 15% Azolla, there was no difference. These findings corroborate those of Chichilichi *et al.,* (2014) who found non-significant ($p \geq 0.05$) better efficiency upon supplementation of enzyme in diets containing 0, 5 or 10% Azolla. Several studies suggest beneficial effects of enzyme supplementation on feed efficiency (Rajeshwara and and Devegowda., 1996), (Choct *et al.,* 1995) and (Saxena *et al.,* 2006)

Economics of production

The economics of production, for the birds in different groups, are presented in the Table 8. Each of Azolla fed groups showed higher economic efficiency than the control. Between the Azolla fed groups, group T3 showed the highest efficiency followed by groups T4, T2 and T1, in that order. The higher efficiency shown by the Azolla fed groups were due to greater feed efficiency and weight gain because of feeding Azolla.

Economisation of feed cost in poultry by dietary inclusion of Azolla at different levels has been reported by several authors (Subudhi and Singh 1978) reported that feed cost could be economised by replacing 20-25% of commercial feed by fresh Azolla. Seth *et al.,* (2014) recorded lowest feed cost for the 15% Azolla by incorporating 0,5,10 or 15% Azolla in the diet of vanaraja birds. But Basak *et al.,* (2002) reported that 5% Azolla fed group had the highest profit/bird as compared to 0, 10 or 15% Azolla fed groups. Chichilichi *et al.,* (2014) also reported highest profit margin at 5% level of Azolla inclusion compared to 0 or 10% level. Naghshi *et al.,* (2014) also reported that the lowest feed cost/kg body weight was for diets containing 5% Azolla in comparison to 10 or 15% inclusion. The differences observed between the present study and reported works could be attributed to chicken types, feed and environmental condition in these experiment.

From above discussion, it was concluded that Azolla could be included in the broiler ration up to 15% level which resulted in higher body weight gain and feed efficiency. It leads to substantial economisation of feed cost of production.

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