



Effect of Feed Restriction and Garlic Supplementation on Growth Performance, Nutrient Utilization and Meat Quality in Female Broiler

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ABSTRACT

An experiment was conducted to study the effects of feed restriction and garlic supplementation on growth performance, nutrient utilization and meat quality in female broilers. In this study, 120, day-old female broilers were randomly distributed into 5 treatment groups each having 4 replicates with 6 birds in each replicate. Diets were formulated as per ICAR 2013 specifications and were fed in 3 phases. Treatment T_1 served as control. The other treatments comprised: $T_2=T_1$ with feed restriction (10-12 h) at 8-17 days of age (DOA) with garlic supplementation, $T_3=T_1$ with feed restriction at 8-17 DOA (10-12 h) without garlic supplementation, $T_4=T_1$ with feed restriction at 18-27 DOA (10-12 h) with garlic supplementation, $T_5=T_1$ with feed restriction at 18-27 DOA (10-12 h) without garlic supplementation. Early feed restriction (8-17 DOA) without garlic supplementation reduced ($P<0.05$) the average body weight gain at 2nd and 3rd weeks of age. Garlic supplementation and late feed restriction (from 18-27 DOA) reduced ($P<0.05$) the average body weight gain at 4th week of age. Significantly ($P<0.05$) reduced average feed intake was observed in birds subjected to early feed restriction (8-17 DOA) with garlic (T_2) and without garlic (T_3) at 2nd and 3rd week of age as compared to control (T_1). There was no significant effect on feed conversion ratio (FCR) of early and late feed restriction with or without garlic supplementation except at 5th week of age where FCR was observed to be better ($P<0.05$) in T_4 group of birds with late feed restriction and garlic supplementation as compared to control (T_1) and late feed restriction without garlic supplementation (T_5). Early and late feed restrictions with garlic supplementation (T_2 and T_4) resulted in significantly ($P<0.05$) higher crude protein and organic matter metabolizability as compared to control (T_1). Garlic supplementation with early and late feed restriction (T_2 and T_4) improved meat quality, had significantly ($P<0.05$) better color and appearance, odour, texture, juiciness as well as overall acceptability than the control (T_1). It was concluded that early feed restriction without garlic supplementation reduced the feed intake at 2nd and 3rd week of age and improved meat quality.

Key words: Female birds, Feed restriction, Garlic supplementation, Meat quality, Nutrient retention

INTRODUCTION

Poultry industry is one of the major industries that are supporting the nutrient supply of the huge population of the world. As we know feed contributes about 70 percent cost of poultry production. But if feed is offered *ad-libitum*, it is unfortunately accompanied by certain ill-effects like high metabolic rate, high mortality, and skeletal defects. Feed restriction is a method of feeding in which the time or duration or amount of feed is limited and had significant effect on the subsequent ability of broilers to recover from a growth defect. Male broilers have a greater ability to exhibit compensatory growth following a period of under nutrition than females (McMurtry *et al.*, 1988, Plavnik and Hurwitz 1991).

At the present time, there is increasing pressure to reduce or eliminate the use of antibiotics in poultry feed and to look for alternative growth promoters like garlic. The major active ingredients in garlic are allicin, ajoene, dialkyl polysulphides, s-allylcysteine and it also possesses at least 33 sulphur containing compounds, several enzymes, amino acid and minerals. Supplementation of garlic powder at 1.5% gave best response in terms of growth performance (Singh *et al.*, 2015). Though both feed restriction and garlic supplementation have a beneficial effect on broiler performance but synergistic effect of feed restriction without or with garlic supplementation in female birds is still to be studied. So, this study was conducted to assess the effect of feed restriction along with garlic

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supplementation on performance of broilers.

MATERIALS AND METHODS

The present investigation was carried out to study the effect of feed restriction and garlic supplementation in female broilers at the Department of Animal Nutrition, GADVASU, Ludhiana, Punjab. One hundred and twenty female, day-old meat type chicks (IBL-80) were distributed randomly into 5 groups having total 24 birds per treatment with 4 replicates having 6 chicks in each replicate representing different treatments which were as follows: T_1 - Control group fed *ad libitum* as per ICAR specification i.e. starter diet (22% CP and 3000 kcal/kg ME), grower diet (21.5% CP and 3050 kcal/kg ME) and finisher diet (19.5% CP and 3100 kcal/kg ME). The other treatments were $T_2=T_1$ with feed restriction at 8-17 DOA (10-12 h) with garlic supplementation, $T_3=T_1$ with feed restriction at 8-17 DOA (10-12 h) without garlic supplementation, $T_4=T_1$ with feed restriction at 18-27 DOA (10-12 h) with garlic supplementation, and $T_5=T_1$ with feed restriction at 18-27 DOA (10-12 h) without garlic supplementation. The percent ingredient composition of rations fed the three phases that was kept were formulated to meet nutrient requirements as per ICAR (2013) specifications is presented in Table-1. The feeders were removed for 10-12 hours during 8 PM. to 8 AM. (next day) to apply feed restriction.

A metabolic trial of three days collection period was conducted at the end of experiment. Four birds of comparable body weight were selected from each treatment and were housed in battery brooders. There were 2 replicates of each treatment having 2 birds in each replicate. All the faecal collection trays and feeding trays were cleaned properly to start the metabolic evaluation. After adaptation period of five days the measured quantity of feed for three consecutive days was offered to each replicate both in the morning and evening. The residual feed left was removed on 4th day and weighed to record the actual consumption of feed for each replicate. The excreta voided by each replicate were collected daily in the morning and weighed. A separate aliquot was collected in 25 ml of 10 % sulphuric acid to avoid nitrogen loss. Excreta

Table 1: Percent ingredient composition of experimental diets

Ingredients (kg/100 kg)	Starter phase					Grower phase					Finisher phase				
	T_1	T_2	T_3	T_4	T_5	T_1	T_2	T_3	T_4	T_5	T_1	T_2	T_3	T_4	T_5
Maize	54.85	54.35	54.85	54.35	54.85	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0
Soybean Meal	33.5	33.5	33.5	33.5	33.5	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
Groundnut Extraction	4.5	4.0	4.5	4.0	4.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
De-oiled Rice Bran	1.0	0.5	1.0	0.5	1.0	5.0	3.5	5.0	3.5	5.0	5.0	3.5	5.0	3.5	5.0
Garlic	-	1.5	-	1.5	-	-	1.5	-	1.5	-	-	1.5	-	1.5	-
Oil	2.5	2.5	2.5	2.5	2.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Di-calcium Phosphate	1.5	1.5	1.5	1.5	1.5	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Limestone Powder	1.5	1.5	1.5	1.5	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Methionine (g)	150	150	150	150	150	100	100	100	100	100	100	100	100	100	100
Salt (g)	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Additives*(g)	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Total (Kg)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

* Additives include vitamin A 8,25,000 IU, vitamin D3 1,20,000 IU, vitamin K 100 mg, riboflavin 500 mg, thiamine 80 mg, pyridoxine 160 mg, vitamin E 800 mg, cyanocobalamin 100 mcg, niacin 1200 mg, calcium pantothenate 80 mg, manganese sulphate 25 g, ferrous sulphate 10 g, copper sulphate 500 mg, zinc oxide 8 g potassium iodide 100 mg, coccidiostat 60 g.

collected for three consecutive days of each replicate were mixed properly. The sample of excreta after drying at 80°C were grounded and analyzed for various proximate parameters (AOAC, 2005). The protein (PER) and calories efficiency ratio (CER) were calculated using standard procedures. Meat samples from sacrificed birds were sent to Department of Livestock Products and Technology, GADVASU where sensory evaluation was conducted by expert panel of 7 analysts on 8-point Hedonic scale. The data collected in the experiment were subjected to statistical analysis using one-way ANOVA using Software Package for Social Sciences (SPSS, version 22.0).

RESULTS AND DISCUSSION

The data pertaining to effect of feed restriction and garlic supplementation on growth performance in female broiler is presented in Table 2. Early feed restriction without garlic supplementation (T_3) significantly ($P<0.05$) reduced the average body weight gain at 2nd and 3rd week of age as compared to control (T_1). But, early feed restrictions with garlic supplementation (T_2) had no significant difference as compared to control (T_1) at 2nd and 3rd week of age. Early feed restrictions with garlic supplemented group (T_2) had significantly ($P<0.05$) better results as compared to late feed restrictions without garlic supplementation (T_5) at 4th week of age. There was no significant effect of garlic supplementation and feed restriction at 1st and 5th week of age. Significantly ($P<0.05$) reduced average body weight gain due to feed restriction was reported by Malpotra *et al.* (2017), Omosebi *et al.* (2014) and Zhan *et al.* (2007).

Significantly ($P<0.05$) reduced average feed intake was observed in early feed restriction (8-17 DOA) with garlic (T_2) and without garlic (T_3) at 2nd and 3rd week of age as compared to control (T_1). Irrespective of age late feed restrictions (18-27 DOA) with or without garlic (T_4 and T_5) had no significant effect on average feed intake as compared to control (T_1). However, late feed restrictions with or without garlic supplementations (T_4 and T_5) had significantly ($P<0.05$) reduced average feed intake as compared to T_2 at 4th week of age. It was indicated that early feed

restrictions with or without garlic supplementation (T_2 and T_3) reduced the feed intake at 2nd and 3rd week of age. However, in late feed restrictions with or without garlic supplementation (T_4 and T_5) the average feed intake remained unaffected. Significant ($P<0.05$) reduction in feed intake due to feed restrictions was reported by Mehmood *et al.* (2013). Also, feed intake was significantly reduced due to duration of restriction and level of restriction (Omosebi *et al.*, 2014). But, Saber *et al.* (2011) and Afsharmanesh *et al.* (2016) observed non-significant feed intake due to feed restriction in their respective studies.

There was no significant difference in feed conversion ratio from 1st to 4th week of age. But at 5th week of age, T_4 group of birds with late feed restriction and garlic supplementation had significantly ($P<0.05$) better feed conversion ratio as compared to control (T_1) and late feed restriction without garlic supplementation (T_5). Malpotra *et al.* (2017) and Omosebi *et al.* (2014) had reported ($P<0.05$) better FCR with feed restrictions. But, Sidhu *et al.* (2017) and Saber *et al.* (2011) did not found any significant effects of feed restrictions on FCR. Earlier research workers (Raeesi *et al.*, 2010; Patel *et al.*, 2017; Ratika *et al.*, 2018) reported better FCR in garlic powder supplemented groups. But, Onibi *et al.* (2009) did not found any significant difference in FCR in garlic supplemented broilers.

There was no significant difference in PER due to early and late feed restriction with or without garlic supplementation in different weeks of age from 1st to 5th week of age. Garlic supplementation in early and late feed restrictions had no significant effect on protein efficiency ratio. However, in overall period, PER was numerically higher in feed restricted groups and garlic supplemented groups (T_2 and T_4) as compared to control (T_1). Sidhu *et al.* (2017) and Butzen *et al.* (2015) reported no significant differences in PER during different phases due to feed restrictions. Ratika *et al.* (2018) reported that PER was significantly ($P<0.05$) better in garlic supplemented groups than the control group. But, PER was significantly ($P<0.05$) higher in feed restricted group during 2nd week and fourth week;

similarly improved PER due to feed restriction during 4th week was reported by Malpotra *et al.* (2017). Overall ($P<0.05$) improved protein feed efficiency due to feed restrictions followed by compensatory growth was reported by Al-Taleb (2003).

There was no significant difference in CER due to early and late feed restriction with or without garlic supplementation in different weeks of age from 1st to 5th week of age. Sidhu *et al.* (2017) also reported no significant difference in the CER due to feed

restrictions. But, Malpotra *et al.* (2017) observed that feed restriction during 2nd week gave significantly ($P<0.05$) higher value of CER during 2nd week and 4th week, CER was found significantly ($P<0.05$) lower during fourth week in feed restricted groups; but during 5th week, feed restricted groups gave significantly better value. Saleh *et al.* (2005) also reported ($P<0.05$) improved calorie efficiency ratio following feed restrictions. But, effect of garlic supplementation in early and late feed restrictions in female broiler is not

Table 2. Effect of feed restriction and garlic supplementation on growth performance in female broilers

Period	Treatment groups					S.E.M
	T ₁	T ₂	T ₃	T ₄	T ₅	
Average body weight gain						
1 st week	84.47	85.95	83.37	84.41	82.63	0.813
2 nd week	149.87 ^a	139.437 ^{ab}	132.54 ^b	150.41 ^a	148.93 ^a	2.077
3 rd week	222.35 ^{ab}	216.79 ^{ab}	214.75 ^b	224.77 ^a	221.89 ^{ab}	1.395
4 th week	247.77 ^{ab}	252.14 ^a	248.41 ^{ab}	244.22 ^{ab}	243.33 ^b	1.278
5 th week	320.29	325.72	318.22	326.16	321.82	1.562
Average feed intake						
1 st week	144.37	142.32	140.25	141.55	137.88	1.051
2 nd week	257.56 ^a	229.36 ^b	229.40 ^b	252.98 ^a	253.78 ^a	2.328
3 rd week	414.794 ^a	399.146 ^b	403.225 ^b	418.61 ^a	420.35 ^a	1.643
4 th week	492.792 ^{ab}	497.40 ^a	492.208 ^{ab}	486.77 ^b	484.72 ^b	1.524
5 th week	776.5	779.57	787.57	773.25	785.52	1.837
Feed conversion ratio						
1 st week	1.70	1.65	1.68	1.67	1.66	0.193
2 nd week	1.71	1.64	1.73	1.68	1.70	0.195
3 rd week	1.86	1.84	1.87	1.86	1.89	0.184
4 th week	1.98	1.97	1.98	1.99	1.99	0.183
5 th week	2.42 ^a	2.39 ^{ab}	2.47 ^a	2.37 ^b	2.44 ^a	0.202
Protein efficiency ratio						
1 st week	2.64	2.73	2.69	2.69	2.71	0.1
2 nd week	2.63	2.75	2.61	2.69	2.65	0.102
3 rd week	2.50	2.53	2.48	2.50	2.46	0.091
4 th week	2.59	2.61	2.60	2.58	2.58	0.09
5 th week	2.14	2.17	2.11	2.17	2.13	0.109
Calorie efficiency ratio						
1 st week	0.195	0.201	0.198	0.199	0.200	0.054
2 nd week	0.194	0.203	0.193	0.198	0.196	0.042
3 rd week	0.175	0.178	0.174	0.176	0.173	0.074
4 th week	0.162	0.163	0.163	0.162	0.162	0.041
5 th week	0.134	0.136	0.132	0.136	0.133	0.042

^{a,b}Values with different superscripts differ significantly ($P\leq 0.05$) within each row

Table 3. Effect of feed restriction and garlic supplementation on nutrient digestibility and meat quality in female broilers

Variables	Treatments					S.E.M.
	T ₁	T ₂	T ₃	T ₄	T ₅	
Nutrient utilization						
N retained (% intake)	60.69 ^b	64.10 ^a	60.31 ^b	63.87 ^a	60.16 ^b	0.832
AMOM (%)	70.54 ^b	75.70 ^a	70.68 ^b	74.54 ^a	69.58 ^b	0.757
Ca retained (% intake)	48.63	48.70	48.41	48.68	48.46	0.212
P retained (% intake)	46.12	46.17	45.90	46.19	45.95	0.378
Meat quality						
Color and Appearance	7.07 ^b	7.46 ^a	7.14 ^b	7.34 ^a	7.09 ^b	0.131
Odour	6.75 ^b	7.41 ^a	6.72 ^b	7.35 ^a	6.79 ^b	0.127
Texture	6.97 ^b	7.14 ^a	6.84 ^b	7.09 ^a	6.93 ^b	0.146
Juiciness	7.14 ^b	7.41 ^a	6.94 ^b	7.35 ^a	6.97 ^b	0.138
Overall acceptability	6.96 ^b	7.35 ^a	6.91 ^b	7.24 ^a	6.88 ^b	0.144

^{a,b}Values with different superscripts differ significantly ($p \leq 0.05$) within each row

available in the literature.

Data pertaining to effect of feed restriction and garlic supplementation on nutrient utilization and meat quality in female broiler is presented in Table 3. Early and late feed restrictions with garlic supplementation (T₂ and T₄) gave significantly ($P < 0.05$) higher apparent metabolizability of organic matter and N retention as compared to control (T₁). There was no significant difference in apparent retention of calcium and phosphorus due to early and late feed restriction with or without garlic supplementation. But, Teeter and Smith (1985) reported that feed restriction increased nutrient digestibility. However, significantly ($P < 0.05$) lower value for phosphorus retention were observed in third week of restrictions as compared to second week of restrictions as reported by Malpotra *et al.* (2017). Singh *et al.* (2017) reported significantly ($P < 0.05$) higher calcium in garlic supplemented diets but dry matter metabolizability, ether extract digestibility, percent nitrogen and phosphorus retention remained unaffected. Sidhu *et al.* (2017) reported significant ($P < 0.05$) increase in digestibility coefficients of ether extract in feed restricted groups.

Data pertaining to meat quality parameters revealed that garlic supplementation with early and late feed restriction (T₂ and T₄) had significantly ($P < 0.05$) better color and appearance, odour, texture, juiciness and as well as overall acceptability of meat than the

control (T₁). Similarly, Singh *et al.* (2015) reported that supplementation of whole bulb garlic powder at 1.0, 1.5 and 2.0 % supplementation levels lead to significantly ($P < 0.05$) better appearance and color, flavour, tenderness, juiciness and overall acceptability of chicken meat. Kim *et al.* (2009) also observed positive influence of garlic supplementation on culinary traits of poultry meat. Malpotra *et al.* (2017) reported that odour was unaffected by feed restriction while colour, texture, juiciness and overall acceptability were significantly ($P < 0.05$) better during 2nd week feed restriction. It showed that garlic supplementation was useful in enhancing the quality of the meat of female birds.

CONCLUSIONS

From the study it was concluded that early feed restriction without garlic supplementation significantly reduced the average body weight gain and average feed intake at 2nd and 3rd week of age in female birds. Late feed restriction and garlic supplementation had better feed conversion ratio at 5th week of age. Garlic supplementation with early and late feed restriction improved colour and appearance, odour, texture, juiciness and as well as overall acceptability meat.

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