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Mob: +92 300 3008585, Fax: +92 41 8815544
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Effect of Diet Dilution in the Starter Period on Performance and Carcass Characteristics of Broiler Chicks

A. Teimouri[1], M. Rezaei[1], J. Pourreza[2], H. Sayyahzadeh[1] and P.W. Waldroup[3]
[1]Department of Animal Science, Faculty of Agriculture, University of Mazandaran, P.O. Box 578, Sari, Iran
[2]Department of Animal Science, Faculty of Agricultur, University of Technology, Isfahan, P.O. Box 8415683111, Isfahan, Iran
[3]Department of Animal and Poultry Science, University of Arkansas, Fayetteville, AR 72701, USA

Abstract: The effect of energy and protein dilution in the starter period (8 to 14 days) of age, on performance and carcass characteristics of 360 Arian male chicks was studied in a completely randomized design. This experiment consisted of 6 treatments, 4 replicates, with 15 chicks per replicate. In order to dilute the diets six levels (0, 4, 8, 12, 16, and 20) percent of ground wood charcoal was used. Chicks were fed with starter and grower diet from 15 to 21 and 22 to 42 days of age respectively. During the experiment feed intake, body weight gain, feed conversion ratio were measured weekly. Mortality was measured throughout the experiment. At 43 day of age 4 chicks each treatment was selected and carcass characteristics were measured. The results indicated that dilution of diet from 8 to 14 days of age increased feed intake in this period but, the differences were not significant. With increasing dilution rate body weight gain of chicks significantly decreased in comparison to control group ($P< 0.05$). Due to compensatory growth after restricted period, there was not significant difference in body weight among restricted and control groups at 42 days of age. There was not significant difference among the treatments for feed conversion ratio in whole period of the experiment (8 to 42 day). Similarly, there was not significant difference among the treatments for caloric conversion ratio in whole period of the experiment (8 to 42 day). Mortality rate in restricted groups was significantly lower than control group ($P<0.05$). Diet dilution hadn't significant effect on carcass, breast meat, drumsticks, thighs, liver, intestine, abdominal fat percentages. The results of the present study indicated that broiler chicks can withstand a 7-day period (from 8 to 14 days) feed restriction with ground wood charcoal in early age without loss in performance.

Key words: Broiler chicks, dilution, wood charcoal, performance

Introduction

Feeding strategy in growing broiler chickens should be to produce animals with maximum lean body mass, highest feed conversion ratio and maximum body weight. Continuous genetic selection and improvement in nutrition have led to a very fast growth rate in modern strains (Plavnik and Hurwitz, 1985, 1988, 1991; Lippens *et al*., 2000, 2002; Tumova *et al*., 2002). To the extent that the time required growing a broiler chicken to 2 kg has decreased from 63 d to 37 d (Zubair and Leeson, 1996a). Research shows that the improved growth rate results from a large increase in early postnatal growth rate (Lippens *et al*., 2000). The early-life fast growth rate is accompanied by a number of problems, namely increased body fat deposition, high incidence of metabolic disorders, high mortality, and high incidence of skeletal diseases. To tackle with these problems early nutrient restriction programmers were used (Leeson *et al*., 1991; Lee and Leeson, 2001; Lippens *et al*. 2000, 2002; Tumova *et al*., 2002; Urdaneta-Rincon and Leeson, 2002; Saleh *et al*., 2005). Feed restriction and diet dilution cause temporary reduced growth rate, assuming that normal weight is realized at market age, feed efficiency should be improved (Lee and Leeson, 2001). Early feed restriction of broiler chickens is usually applied in order to induce catch-up growth and improved efficiency of feed utilization (Susblia *et al*., 2003). Experimental results show considerable variation in the responses of chicken to feed restriction (Scheideler and Baughman., 1993; Zubair and Leeson, 1996a; Susblia, *et al*., 2003). Reasons for the relative success or failure of feed-restricted chickens to achieve full body weight recovery following realimentation are still unknown (Susblia *et al*., 2003). Dilution of the diet with oat hulls, rice bran, cellulose or another inert filler can be a rather easy way to induce growth retardation (Lippens *et al*., 2002). Leeson *et al*. (1991) found a complete recovery of body weight at the age of 42 d, after diet dilution with ground rice hulls up to 55 % from 4 to 11 d of age. The overall efficiency of feed utilization was not affected. However, there was an indication of reduced abdominal fat content for males at 56 days of age. Lee and Leeson (2001) reported that male broiler fed diets diluted up to 50 % with oat hulls from 7 to 14 days, caught up body weight by 8 wk of age but had abdominal fat levels similar to control birds. Breast meat yield also was decreased. As far as we are aware, wood charcoal has not been tested as a inert filler in broiler chickens diets.

Table 1: Composition (%) and calculated nutrient content of diets

Ingredients and Composition (%)	Starter	Test diet					Grower
	1(control)	2	3	4	5	6	
Corn	54.40	52.16	49.94	47.56	45.07	42.97	64.15
Soybean meal	40.16	38.34	36.46	34.71	33.14	31.03	31.88
Wood charcoal	----	4.00	8.00	12.00	16.00	20.00	----
Soy oil	2.00	1.96	1.92	1.91	1.93	1.86	1
Dicalcium phosphate	1.30	1.33	1.37	1.41	1.44	1.49	0.84
Oyster shell	1.28	1.27	1.27	1.26	1.25	1.25	1.35
Salinomycin	0.05	0.05	0.05	0.05	0.05	0.05	0.05
L-Lysine	----	0.05	0.12	0.2	0.18	0.33	----
Salt	0.29	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine	0.09	0.13	0.16	0.19	0.22	0.26	0.01
Mineral premix[1]	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin permix[2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100
Calculated analysis							
ME (KcaL /Kg)	2900	2784	2668	2552	2436	2320	2950
Crude protein (%)	20.9	20.0	19.2	18.39	17.55	16.7	18.4
Calcium (%)	0.89	0.89	0.89	0.89	0.89	0.89	0.79
Available phosphorus (%)	0.30	0.40	0.40	0.40	0.40	0.40	0.40
Sodium (%)	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Arginine (%)	1.58	1.58	1.44	1.37	1.31	1.23	1.36
Lysine (%)	1.30	1.28	1.28	1.28	1.21	1.26	1.08
Methionine (%)	0.45	0.47	0.49	0.50	0.52	0.54	0.34
Methionine+cystine (%)	0.81	0.82	0.82	0.82	0.82	0.82	0.66

[1]Mineral mix supplied the following per kg of diet: Cu, 20 mg; Fe, 100 mg; Mn, 100 mg; Se, 0.4; Zn, 169.4 mg.

[2]Vitamin mix supplied the following per kg of diet: vitamin A, 18000 IU; vitamin D_3, 4000 IU; vitamin E, 36mg; vitamin K_3,4 mg; vitamin B_{12}, 0.03 mg; thiamine, 1.8 mg; riboflavin, 13.2 mg; pyriod oxin, 6 mg; niacin, 60 mg; calcium pantothenate, 20 mg; folic acid, 2 mg; biotin, 0.2; cholin chloride, 500 mg.

In this experiment, wood charcoal was used as new inert filler. Therefore, the present study was conducted to evaluate the effect of feed restriction with using wood charcoal on performance, carcass characteristics and mortality of Arian (Hybro) male broiler chicks.

Materials and Methods

In this experiment, diet dilution was achieved by substitution of ground wood charcoal for the major ingredients in the diet (Diets 2, 3, 4, 5 and 6). The experimental diets, containing 0 (zero), 4, 8, 12, 16, 20 % ground wood charcoal were formulated to be isonitrogenous and isocaloric by using maize, soybean meal, soy oil as main ingredients (Table 1). Chicks were fed with a commercial starter diet from 1 to 7 days of age. At d 8 chicks were distributed among 24 experimental pens (1×2 m). Between 15 to 21 days of ages, all birds were fed the regular starter diet (Table 1). After this period, chicks were fed with a regular grower diet up to 42 days of age (Table 1). All diets were formulated to meet the nutrient requirements according to NRC (1994). Ground wood charcoal contains 94.1 % DM, 14.5 % ash, 75.7 % CF, 2.16 % CP, 1.08 % EE, and 0.66 % NFE. A total of 360 male broiler chicks (Arian) were obtained from a commercial hatchery. During the experiment weight gain, feed intake and feed conversion ratio were measured weekly. Mortality was measured throughout the experiment. At the end of the experiment (43d) 1 bird from each pen with body weight close to the pen average selected for carcass analyses. After feed withheld for 9h, the selected birds were transported to the university pilot for processing. The chickens were slaughtered by cervical dislocation to determine the carcass characteristics.

Statistical analysis

Data of this experiment were analyzed by analysis of variance using General Linear Models (GLM) procedures (SAS Institute, 2001). Differences among treatments were separated by Duncan's Multiple Range Test (1955). Percentage data for processing effects were converted to Arc sine before analysis. Mortality data were transformed to $\sqrt{n+1}$ prior to analysis. The level of significance was reported at $P<0.05$

Results and Discussion

Effect of diluted diets on feed intake, body weight gain, feed conversion ratio, calorie conversion ratio, carcass

characteristics and mortality are presented in Tables 2 and 3.

Feed intake: During the period of diet dilution, birds attempted to maintain nutrient intake by consuming more feed, thus increasing degrees of diet dilution resulted in graded increase in feed intake (Table 2). This is in contrast with the findings of Leeson *et al.*, 1991 and Yussefi Kelaricolaii *et al.*, 2001. If wood charcoal is excluded from the calculation of feed intake (assumed indigestible) the feed intake of birds in treatments 4, 5 and 6 reduced ($P<0.05$). During the 15 to 42 day (realmentation period), diet dilution hadn't significant effect on this trait. Similarly feed intake between 8 to 42 day wasn't affected by the diet dilution in 8 to 14 days of age. Results of this experiment (the present study) are in agreement with the finding of other studies (Lee and Leeson, 2001 ;Yussefi Kelaricolaii *et al.*, 2001). It seems that due to using low levels of wood charcoal in diets, there weren't significant difference among treatments in whole period of the experiment for this trait.

Body weight gain: With increasing Diet dilution there was a corresponding reduction in body weight gain by 7% in treatment 6. When birds resumed eating the regular undiluted starter diet after 14 days of age, prior diet dilution hadn't significantly effect on BWG. There weren't significant difference among treatments in whole period of the experiment. Results of this study are in agreements with findings of Leeson *et al.* (1991), Lee and Leeson (2001), Yussefi Kelaricolaii *et al.* (2001) Lippens *et al.* (2002). With increasing feed restriction (treatment 6) birds could not obtain the nutrients that are necessary for the normal growth.

Feed conversion ratio: During the period of diet dilution (8 to 14 days of ages), no significant difference was observed between birds fed with diluted and control diets. If wood charcoal is again assumed to be indigestible, then adjusted feed conversion ration was improved in treatments 4, 5 and 6 ($P<0.05$). There wasn't significant difference among treatments for this trait in whole period of the experiment (8 to 42). With excluding wood charcoal in diets feed conversion ratio was improved in treatment 2, 4 in whole period (8 to 42). This results in agreement with the findings of Lee and Leeson (2001) Yussefi Kelaricolaii *et al.* (2001). The improvement in feed conversion ratio observed in feed restricted chickens has been attributed to reduce over all maintenance requirements caused by a transient decrease in basal metabolic rate. However, the improved feed conversion ratio can also be related to higher feed and to the enlargement of the gastrointestinal tract that occurs after the restriction period, when the birds are fed *ad libitum*.

Calorie conversion ratio: This measurement may be more economically important estimate of the ability of the birds to utilize their diets that is feed conversion. During the period of diet dilution (8 to 14 days), calorie conversion ratio was improved in treatment 4 and 5 ($P< 0.05$). If wood charcoal is again assumed to be indigestible, then adjusted calorie conversion ratio was significantly reduced for treatment 3, 4, 5 and 6. There wasn't significant different among treatments for this trait in whole period of the experiment (8 to 42). The results of the present study are in agreement with finding of other researchers (Saleh *et al.*, 2004, 2005).

Mortality: As expected, Mortality following diet dilution was significantly lower for bird that was restricted at 8 to 14 d. Many investigators have reported a reduction in mortality rate following feed restriction (Arce *et al.*, 1992; Robinson *et al.*, 1992; Tumova *et al.*, 2002; Saleh *et al.*, 2004, 2005).This could provide the greatest economic incentive for implementing early feed restriction by allowing for more birds to be marketed from a flock. In present study, mortality was reduced in restricted groups of chicks. The two main metabolic disorders affecting contemporary broiler chickens are ascites and SDS. These pathologic conditions are closely related to rapid growth rate and increase feed intake. Feed restriction slows down fast growth to reduce late mortality, including preascites and ascites (Tumova *et al.*, 2002; Saleh, *et al.*, 2004, 2005). Feed restriction decreased mortality caused by "sudden death syndrome" (Lippens *et al.*, 2000). In this experiment implementation of feed restriction significantly reduce the prevalence of these disorders, which is in agreement with observations of Julian (1997), Gonzales (1998a) but in contrast with Robinson *et al.* (1992) and McGovern *et al.* (1997) and Urdaneta-Rincon, and Leeson (2002). Effect of diluted diets on survivability rate of male broiler chicks is shown in Fig. 1.

Carcass characteristics: Carcass weight expressed as the percent of live weight was not affected by feed restriction. Thighs, Drumsticks, Breast meat, Intestine, Liver, Abdominal fat pad percentage were not affected. One of the most controversial aspects of early feed restriction programmes has been lack of a consistent effect on abdominal fat pad (Lippens *et al.*, 2000). A reduction in abdominal fat content with concomitant reduction in body weight was found by Plavink and Hurwitz (1985, 1988, 1991) and Jones and Farrell (1992). Other investigators have reported reductions in abdominal fat pad due to early life feed restriction but a small reduction in final body weight (Cabel, and Waldroup, 1990). Others (Leeson *et al.*, 1991; Lee and Leeson, 2001; Urdaneta-Rincon, and Leeson, 2002; Saleh *et al.*, 2004, 2005) were not able to show a clear effect. Beane *et al.* (1979) reported that feed efficiency

Table 2: Effect of diluted diets on feed intake, body weight gain, feed conversion ratio, calorie conversion ratio of male broiler chicks

Treatment	1	2	3	4	5	6	SEM
Feed intake (g)							
8 to 14* d	349	364	345	350	360	358	12.85
8 to 14** d	349^{a}	350^{a}	317^{ab}	310^{b}	302^{b}	286^{b}	11.5
8 to 42* d	4497^{ab}	4372^{b}	4574^{ab}	4368^{b}	4630^{a}	4504^{ab}	64
8 to 42** d	4497^{abc}	4358^{bc}	4546^{ab}	4329^{c}	4572^{a}	4436^{abc}	64.5
15 to 42 d	4027	4021	4269	4010	4262	4370	88.5
Body weight gain (g)							
8 to 14 d	256^{a}	265^{a}	252^{a}	267^{a}	258^{a}	238^{b}	5.5
8 to 42 d	1901	1894	1921	1967	1930	2004	71
15 to 42 d	1639	1671	1679	1638	1710	1765	71.85
Feed conversion ratio							
8 to 14 *d	1.345	1.355	1.360	1.300	1.382	1.470	0.05
8 to 14** d	1.345^{a}	1.320^{ab}	1.250^{abc}	1.140^{bc}	1.125^{bc}	1.150^{bc}	0.05
8 to 42* d	2.227	2.307	2.385	2.250	2.467	2.200	0.11
8 to 42** d	2.227^{a}	2.142^{b}	2.295^{a}	2.120^{b}	2.250^{ab}	2.205^{ab}	0.04
15 to 42 d	2.422	2.292	2.525	2.440	2.475	2.385	0.04
Calorie conversion ratio (ME kcal/kg)							
8 to 14* d	3939^{a}	3838^{ab}	3332^{c}	3392^{bc}	3480^{abc}	149.12	
8 to 14** d	3939^{a}	3687^{ab}	3346^{bc}	2959^{cd}	2848^{d}	2777^{d}	138.83
8 to 42* d	6529	6395	6524	6160	6461	6329	159
8 to 42** d	6529	6234	6618	6244	6380	6228	124
15 to 42 d	7219	7011	7524	7354	7160	7165	331.8

Means within rows with no common superscripts differ significantly ($P < 0.05$).

** Feed intake, Feed conversion ratio, Calorie conversion ratio excluded the wood charcoal

* Feed intake, Feed conversion ratio, Calorie conversion ratio do not excluded the wood charcoal

Treatments 1, 2, 3, 4, 5, 6 contain 0, 4, 8, 12, 16, and 20 percent of ground wood charcoal, respectively

Table 3: Effect of diluted diets on carcass characteristics and mortality of male broiler chicks

Carcass characteristics and Mortality	Treatment						
	1	2	3	4	5	6	SEM
Live weight (g)	1928	1826	1851	1823	1951	1915	9.2
Carcass weight (g)	1305	1249	1232	1294	1298	1318	8.48
Carcass (%LW[1])	67.68	68.37	66.68	71.24	67.80	68.78	1.69
Breast (% CW[2])	25.43	26.05	26.74	23.47	26.08	25.64	1.12
Thighs (% CW)	14.60	14.56	14.25	14.85	14.98	14.24	0.67
Drumsticks (% CW)	13.09	13.18	14.02	14.10	13.68	13.58	0.69
Liver (% CW)	4.17	4.32	3.98	4.23	4.54	4.39	0.54
Intestine (% CW)	8.52	9.02	9.55	9.09	9.07	8.89	0.91
abdominal fat content (% CW)	2.79	2.60	2.80	2.67	2.38	2.60	0.65
Mortality (8 to 42 %)	8.278^{a}	0.00^{b}	3.503^{b}	3.503^{b}	3.225^{ab}	0.00^{b}	0.006

Means within rows with no common superscripts differ significantly ($P < 0.05$). [1]Live wieght.

[2]Carcass weight. Treatments 1, 2, 3, 4, 5, 6 contain 0, 4, 8, 12, 16, and 20 percent of ground wood charcoal, respectively.

was improved, but the amount of abdominal fat in male broilers was significantly increased. Zubair and leeson (1996b) showed that feed-restricted birds usually had a numerically smaller abdominal fat pad. This agrees with the current results. The fact that there was no significant reduction in abdominal fat deposition in this experiment suggests that even feed-restricted broiler chickens are still overeating and that the level of feed intake may control de novo lipogensis (Rosebrough and McMurtry, 1993). It seems that a more severe time of feed restriction is necessary to significantly reduced abdominal fat pad. Carcass weight at 43 were not affected by diet dilution .None of the other carcass parts were not significantly influenced by the feed restriction .In contrast to the situation with carcass or abdominal fat content, There are few results on effects of feed restriction on carcass characteristics. Leeson *et al.* (1991), Zubair and Leeson (1994a) and Palo *et al.* (1995b), Lippens *et al.* (2000), Yussefi Kelaricolaii *et al.* (2001) could not demonstrated any effect of feed

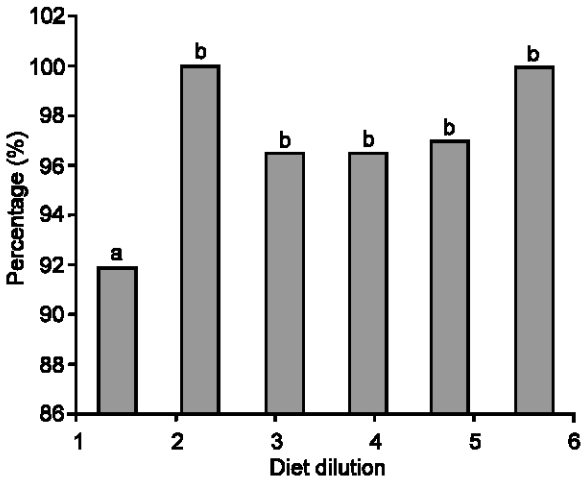

Fig. 1: Effect of diluted diets on survivability rate of male broiler chicks

a,b Means with no common letters differ significantly (P<0.05). Treatments 1, 2, 3, 4, 5, 6 contain 0, 4, 8, 12, 16, and 20 percent of ground wood charcoal, respectively.

restriction in dressing percentage. No effect was found on other carcass characteristics by Leeson (1991); Zubair and Leeson (1994a); palo *et al.* (1995b); Lippens *et al.*, 2000; Yussefi Kelaricolaii *et al.* (2001) and this confirmed by our own results. Other researches found no significant effect of feed restriction on the percentage of thighs or drumsticks (Saleh *et al.* 1996, Lippens *et al.*, 2000). Intestine, Liver percentage were not affected by feed restriction. These results are consistent with palo *et al.* (1995a) and is contrast with Zubair and leeson (1994b). In conclusion, Feed restriction as used in the current trail; give some indication of being a practical tool to reduce losses due to metabolic disease without deteriorating performance and carcass characteristics. Evidently the broiler chicken can withstand a 7-day period of under nutrient without any loss in market weight. More researches however, are needed to confirm this.

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