International Journal of Poultry Science 5 (12): 1156-1159, 2006
ISSN 1682-8356

Effect of Early Feed Restriction on Performance Characteristics and Serum Thyroxin of Broiler Chickens

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Abstract: An experiment was conducted to evaluate the effect of early feed restriction on performance characteristics and serum thyroxin of broiler chickens. The experiment was designed in a 2 x 2 factorial with 5 replicates of floor pens with 12 male or female chicks in each. 240 male and/or female day-old chicks were weighted and randomly allocated to two treatment groups of each sex. Two treatments involved, control group and restricted group, which were fed a mixture of 50:50 rice hulls and commercial starter diet with supplementation of trace minerals and vitamin premixes from 4 to 11 days of age. All groups were fed the same starter, grower and finisher diets from 11 to 56 days of age. Live body weight of restricted birds was compensated on day 42 of age and was numerically more than restricted group at 49 and 56 days of age. Daily feed intake up to 42, 49 and 56 days of age wasn't affected by treatments. Feed efficiency in the restricted birds was significantly ($p<0.05$) better than of control birds up to 56 days of age. Among the body composition, only carcass fat content of restricted birds was significantly ($p<0.05$) lower than of control birds. Abdominal fat pad percent of restricted birds at 49 and 56 days of age was significantly ($p<0.05$) lower than of control birds. T4 concentration on day 11 in restricted group was significantly ($p<0.05$) lower than control group. Its concentration during accelerated growth period was not significantly ($p>0.05$) more than control group.

Key words: Feed restriction, thyroxin, broiler chicken, performance

Introduction

Plavnik *et al.* (1986) in a series of studies showed that restricting metabolizable energy intake to providing only maintenance requirement for a short period early in the life of broilers resulted to a reduction in carcass and abdominal fat without affecting overall growth until 56 day of age. Early feed restriction programs designed to reduce carcass and abdominal fat in broiler chickens rely on the phenomenon called compensatory growth to produce market body weight equal to controls. In recent years, consumer preference for leaner meat has increased due to the corollary between human consumption of certain fats and cardiovascular disease. This has stimulated interest in reducing abdominal fat deposition (Cable and Waldroup, 1990). However, this has proven to be only partially successful and can be costly if high levels of dietary protein are employed. Much attention has been given to the use of compensatory growth and the claim that a leaner carcass will result by the use of such a feeding system. Plavnik and Hurwitz (1985) put birds on a severe feed restriction program at 6 to 7 days of age for a one-week period. While the birds were much reduced in weight by two weeks of age, as compared to the control birds, their claim was that by market age, body weights were similar, feed efficiency was improved and abdominal fat pad was reduced (Plavnik and Hurwitz, 1985). Adipose tissue mass is dependent upon both number and size of individual adipocytes hyperplastic growth of adipose tissue appears to cease by 12 to 15 weeks of age. Although, this age can apparently be altered by nutrient restriction programs (Cherry *et al*., 1984; Plavnik and Hurwitz, 1985; Plavnik *et al*., 1986). Success of feed restriction programs is measured based on complete compensatory growth and the amount of body fat content. Compensatory growth is defined as a recovery from a growth deficit resulting from a limited nutrient intake. Wilson and Osbourn (1960) demonstrated compensatory growth in poultry, following a period of growth retardation by early feed restriction. This means that there is potential to underfeed broiler chickens for some time, without affecting weight at normal market age (Wilson and Osbourn, 1960). Plavnik and coworkers in their researches found that lower carcass fat in broilers subjected to early feed restriction (Plavnik and Hurwitz, 1985; Plavnik *et al*., 1986). This Feeding regimen increases enzyme secretion such as sucrase, amylase and lipase (Pinheiro *et al*., 2004) and also alters functional development of the enzymes of protein digestion such as amino peptidase and dipeptidase and may therefore influence growth rate of broilers. The most common metabolic disease that broilers experience due to excessive growth rates is ascites and sudden death syndrome. Rapid growth rates due to highly concentrated energy feeds increases the occurrence of skeletal disorders. Feed restriction at an early age also can be used as a mean to reduces the occurrences of ascites and sudden death syndrome (McGovern *et al*., 1999; Tottori *et al*., 1997; Urdaneta-Rincon and Leeson, 2002). This temporary feed restriction reduces growth at a critical time in a broiler chick's life cycle when it is the Feeding highly concentrated energy diets without restriction of intake may seem to be the most economically desirable practice in producing broiler chickens, but it increases the occurrences of metabolic and skeletal disease. These diseases not only result in economic losses for the producer, but they greatly affect the welfare of the broilers. Minor alterations in traditional broiler production practices have proven to sustain production and at the same time provide a more desirable living environment. An alternative system of reduced nutrient intake is through diet dilution and rice hulls were chosen as a diluent based upon their almost universal availability (Lesson *et al*., 1991). The mechanism for compensatory growth has not been fully known. Two theories have been proposed to explain how compensatory growth is regulated. First, compensatory growth mechanisms may involve a set-point or reference for body size appropriate for age and that the control resides in the central nervous system (Wilson and Osbourn, 1960). Pituitary gland secretes more growth hormone (GH) is related to compensatory growth control but is not directly responsible for growth acceleration. The link between the compensatory growth control and GH release is regulated by photoperiod. Thus, after a period of undernutrition, the body tries to attain a size that is appropriate for age in the shortest possible time (Zubair, 1994). The second theory relates to so called "peripheral control" which suggests that tissues, *per se,* control body size through cell number or by the total content of DNA (Zubair, 1994). One of involving factors in accelerated growth may be hormonal change during this period. It has been reported that thyroid hormones concentration decreases after feed restriction period but increases and reaches to control by refeeding (Lauterio and Scanes, 1987; Mcmurtry *et al*., 1988). Mcmurtry *et al*. (1988) reported that Growth hormone concentration during compensatory period (days 42) increases in checks that undergo feed restriction. The objective of this experiment was to determine the effect of diet dilution in early of life on performance characteristics and serum thyroxin of broiler chickens.

Materials and Methods

Two hundred forty male and/or female day-old chicks of a commercial strain (Hybrow) were wing banded, weighted and randomly allocated to two treatment groups of each sex. Each replicate floor pen (1.5 m x 1 m) contained 12 birds and each sex contained five replicate floor pens. Temperature was maintained 33°C for first day and gradually reduced according to usual brooding practices. One starter diet was fed to all birds until 4 days. Two treatments involved, one control group (no restriction) and one restricted group, which were fed a mixture of 50:50 rice hulls and commercial starter diet with supplementation of trace minerals and vitamin premixes from 4 to 11 days of age. All groups after feed restriction period were fed ad libitum with same starter, grower and finisher diets from 11 to 56 days of age. Feed restriction was achieved by diet dilution and ground rice hulls was used as diet diluent. On day 49 and 56, one chicken from each replicate with BW close to pen mean was chosen and was slaughtered for body composition analysis. The carcass, breast muscle, tights, wings and abdominal fat pad (including fat adhering to the gizzard and proventriculus) were weighed individually. Moisture content, total protein, total lipid, and total ash of the carcasses were determined. Carcasses were homogenized with an industrial blender. While the homogenized samples were being stirred, subsamples were taken for oven drying. After oven drying for 24 h at 100°C, total dry mater, total protein, total lipid and total ash were analyzed with standard procedures (AOAC, 1980). Group body weight, feed intake and feed efficiency were measured at 4, 11, 18, 21 days and then weekly until end of the experiment. Feed intake, feed efficiency, body composition (protein, fat, ash, dry matter) at 49 days of age, fat pad size at 49 and 56 days of age were determined. Blood sample of one bird from each replicate was obtained by heart puncture when the chickens were 4, 11, 28 and 49 days old. The samples were stored at 2°C in refrigerator for 24 hours and then were centrifuged at 120 RPM for 30 minutes to separate the serums. The obtained blood serum samples were stored at –20 until hormone assay. Serum samples were analyzed for total T4 with radioimmunoassay described by May (1978,1980). The experiment was arranged as a completely randomized design with two factors of sex and feed restriction. Data were analyzed by ANOVA (SAS institute, 1988). Significant differences between means were determined using Duncan's multiple range test.

Results and Discussion

Diet dilution by ground rice hulls slowed growth of restricted birds so that the average live body weight (LBW) was less than non-restricted birds at 11 days. LBW of restricted birds (Table 1) was compensated on day 42 of age, corroborating previously reported results (Lesson *et al*., 1991; Plavnik and Hurwitz, 1985; Zubair and Leeson, 1996) and was greater than restricted group at 49 and 56 days of age (Table 1) which is in agreement with the results of Lee and Leeson (2001). However in experiment of Pinchasov and Jensen (1989) no significant compensatory growth was observed. Osbourn and Wilson (1960) concluded that increased appetite following refeeding is largely responsible for

Table 1: Effect of early feed restriction and sex on carcass composition, feed efficiency, feed intake and live body weight of broiler chickens.

		Body weight (g)			Feed intake (g/b/d)			Feed efficiency			Carcass composition d 49			
		42	49	56	------- Age (day) ---------						---------- Wet basis (%) ---------			
Treatments					0-42	0-49	0-56	0-42	0-49	0-56	DM	CP	Fat[1]	Ash
Main Effects														
Control		1794^{a}	2170^{a}	2557^{a}	87.3^{a}	97.3^{a}	106.0^{a}	2.1^{a}	2.24^{a}	2.36^{a}	40.8	15.93	50.8^{a}	1.98
Restricted		1796^{a}	2208^{a}	2622^{a}	84.4^{a}	95.5^{a}	105.4^{a}	2.0^{a}	2.16^{a}	2.29^{b}	43.2	15.28	39.4^{b}	1.96
Male		1900^{a}	2323^{a}	2753^{a}	87.5^{a}	99.4^{a}	109.1^{a}	1.97^{b}	2.13^{b}	2.25^{b}	42.9	15.49	41.0^{b}	2.07
Female		1691^{b}	2054^{b}	2426^{b}	84.2^{a}	93.4^{b}	102.3^{b}	2.1^{a}	2.27^{a}	2.40^{a}	41.0	15.83	49.3^{a}	1.87
Interactions														
Male	Control	1888^{a}	2276^{a}	2689^{b}	87.3^{a}	97.8^{a}	106.8^{b}	1.98^{b}	2.14^{b}	2.2^{b}	40.89	15.53	42.5^{b}	2.12
Male	Restricted	1912^{a}	2371^{a}	2818^{a}	87.7^{a}	101^{a}	111.4^{a}	1.96^{b}	2.12^{b}	2.2^{b}	45.07	15.25	39.5^{b}	2.02
Female	Control	1700^{b}	2064^{b}	2425^{c}	87.3^{a}	96.8	105.3^{b}	2.20^{a}	2.34^{a}	2.5^{a}	40.69	16.35	59.2^{a}	1.84
Female	Restricted	1681^{b}	2044^{b}	2427^{c}	81.2^{b}	90.0^{b}	99.3^{c}	2.07^{b}	2.20^{b}	2.3^{b}	41.35	15.31	39.3^{b}	1.90
Standard Error		16.0	25.0	26.0	1.25	0.54	1.0	0.02	0.03	0.02	1.73	0.25	2.22	0.11

abcMeans in the same column with a different superscript are significantly different (P<0.05). [1]Carcass fat was determined as dry mater basis.

Table 2: Effect of early feed restriction and sex on carcass composition and serum T4 concentration of broiler chickens

.		Percent of carcass composition (d 49)				Percent of carcass composition (d 56)				T4 (µg/100 ml)		
		Tights	Breast	Wings	Abdominal fat pad	Tights	Breast	Wings	Abdominal fat pad	Age (day)		
Treatments										11	28	49
Main Effects												
Control		21.5	18.7	8.3	3.2	21.5	18.7	8.3	3.20^{a}	2.30^{a}	2.01	2.33
Restricted		21.6	18.4	8.4	2.6	21.6	18.4	8.3	2.57^{b}	1.77^{b}	2.74	2.81
Male		21.9	18.2	8.2	2.9	21.9	18.2	8.2	2.96	2.24	2.12	2.14
Female		21.2	18.9	8.5	2.8	21.2	18.9	8.5	2.81	1.74	1.64	2.49
Interactions												
Male	Control	21.9	18.4	8.2	3.2	21.9	18.4	8.2	3.21	2.52	2.02	2.40
Male	Restricted	22.0	18.0	8.2	2.7	22.0	18.0	8.2	2.71	1.87	1.95	2.50
Female	Control	21.1	19.0	8.4	3.2	21.1	19.0	8.4	3.19	1.86	1.89	2.10
Female	Restricted	21.2	18.8	8.6	2.4	21.2	18.8	8.6	2.42	1.67	1.77	2.80
Standard Error		0.19	0.40	0.50	0.10	0.37	0.49	0.10	0.19	0.10	0.21	0.17

[abc]Means in the same column with a different superscript are significantly different (P<0.05)

any improved growth and feed efficiency associated with compensatory growth. In the present study, there did not seem to be any increased intake immediately following undernutrition. Although birds increasedtheir total feed intake when offered diluted diet, they were not able to maintain normal energy intake. Mean daily feed intake (Table 1) up to 42, 49 and 56 days of age wasn't affected significantly by feed restriction (p>0.05). Feed efficiency as shown in Table 1 in the restricted birds was significantly better than of control birds up to 56 days of age (p<0.05) but it was not significant (p>0.05) up to 42 and 49 days of age. Another response noted with broilers undergoing a period of feed restriction is reduced carcass fat at 42 to 56 days (Plavnik and Hurwitz, 1985). Plavnik and Hurwitz (1985) cited substantial reductions in the size of the abdominal fat pad of broilers that was not influenced by nutrition during refeeding. In the present study (Table 2) abdominal fat percent of restricted birds at 49 and 56 days of age was significantly (p<0.05) lower than of control birds. Early diet dilution may reduce adipocyte hyperplasia. Cherry *et al*. (1984) concluded that although hyperplasia proceeds during periods of nutrient restriction, the adipocytes remain smaller. Similarly Rosebrough *et al*. (1986) observed reductions in both liver size and lipogenrsis in 12 day-old birds subjected to feed restriction from 6 to 12 days. Among the body composition (Table 2), only carcass fat content of restricted birds was significantly lower than of control birds (p<0.05). Also carcass fat content of male chicks was significantly lower than of female chicks (p<0.05). Mean LBW and feed intake up to 42, 49 and 56 days of age for male chicks was significantly (p<0.05) more than female chicks and feed efficiency of the male chicks was significantly better than the females (Table 1). Mean serum thyroxin of the chickens has been shown in Table 2. It was not significantly different at days 4 between the sexes. Serum thyroxin concentration on day 11 in restricted group was significantly lower than control group and its concentration in restricted group during accelerated growth period (28-49 days of age) was insignificantly more than control group. The serum thyroxin significantly (p<0.05)was increased by feed restriction at days 11 (Table 2) but during refeeding period its level reached to control group which is in agreement with the results of Lauterio and Scanes (1987) and Mcmurtry *et al*. (1988). Results of this experiment showed that, broiler chickens after early feed restriction compensate retarded growth and showed less abdominal and carcass fat content. Male broiler chickens productive traits were better than females and serum thyroxin was decreased by feed restriction but reached to control group during compensatory growth period.

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