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EFFECT OF FEED RESTRICTION ON GROWTH PERFORMANCE, SUDDEN DEATH SYNDROME AND SOME BLOOD PARAMETERS IN BROILER CHICKENS

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ABSTRACT

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The study aimed to determine the effects of feed restriction on growth, feed efficiency, sudden death syndrome (SDS) and some blood parameters in broilers. One hundred mixed sex chicks (Avian 48) were randomly allocated into two treatment groups each of 50 chicks (5 replicates). Broilers in the first treatment fed ad libitum until the end of the experiment (35 days of age), while feeds in the other treatment were restricted by 20% from 7 to 21 days. Broilers fed ad- libitum had significantly high body weight gain, better feed conversion and high mortality rate compared with the restricted broilers. Although the mortality rate was significantly higher in ad libitum fed broilers, their better feed efficiency significantly rise the income over feed cost (IOFC). Feed restriction lowered serum lipids and triglycerides associated with macrocytic anemia. Inconclusion, feed restriction negatively affected growth performance, blood parameters and IOFC. Therefore, results support ad libitum feeding for broiler chickens.

Key words: *Broilers, Feed restriction, Performance, Blood parameters, Sudden death syndrome.*

INTRODUCTION

Continuous genetic selection and improvement in nutrition have led to a very fast growth rate in modern strains of broiler chickens. Metabolic disorders such as ascites, sudden death syndrome (SDS) and leg problems are related to a rapid early growth rate in poultry, especially in broilers and their incidence can be decreased by slowing early growth.

The feed restriction programs is one of the main techniques in growth curve manipulation for increasing production efficiency and decreasing the unfavorable effects of fast growth rate in broiler chicken production industry and could be profitable in broiler chickens production efficiency (Sahraei, 2014). Early feed restriction programs rely on phenomenon called compensatory growth or catch up growth to produce market body weight similar to control group. Compensatory growth is defined as a rapid growth after a period of nutritional deprivation. Physical feed restriction is one of the common procedure used to control feed intake in poultry. It is applied by supplying a calculated amount of feed per bird per day (Plavnik and Hurwitz, 1989).

Sudden death syndrome has been reported in most areas of the world that raise broilers intensively. Young, healthy, fast-growing broiler chickens die suddenly with a short, terminal, wing-beating convulsion. Many affected broilers just "flip over" and die on their backs. Feeding, climate, rearing technique, physiological state, age, sex and genotype can influence the level of a particular blood constituent (Meluzzi *et al.*, 1992).

There is less information regarding the effects of feed restriction on feed efficiency, some blood parameters, SDS and lipids profile. Therefore the first aim of this study was to determine the effects of feed restriction during the period from 7 to 21 d on growth, feed efficiency and incidence of SDS. The second aim was to determine the effects of feed restriction on some blood parameters, liver enzymes and lipids profile in broilers.

MATERIALS and METHODS

1. Birds and diets

One hundred mixed sex chicks (Avian 48), obtained from the local hatchery (Abdel Salam Hegazi, Tanta,

Egypt), were randomly allocated into two treatment groups, each of 50 chicks. Each treatment was subdivided into 5replicates, each of 10 chicks, located in floor pens of 100 x120 cm width x length. Broilers in the first treatment fed ad libitum until the end of the experiment (35 days of age), while in the other treatment, broilers fed ad libitum till 7 days of age, then were physically restricted of feed by 20% from 7 to 21 days and again fed ad libitum until the end of the experiment (re-feeding period, from 22 to 35 days). According to the manual of broilers strain, feed restriction was applied by supplying a calculated amount of feed (80% of ad libitum feeding) per bird per day (Plavnik and Hurwitz, 1989). Each pen had woods havings litter, one drinker and one hanging suspended feeder.

Diets were formulated according to nutrient specifications of broiler strain manual. Broilers were fed pelleted starter diet from 1 to 14 days of age (ME=3084 kcal/kg and 22.9% crude protein), grower diet from 15to 28 days of age (ME=3151 kcal/kg and 20% crude protein) and finisher diet from 29 to 35 days (ME=3160 kcal/kg and 18.5% crude protein). Composition of diets for starter, grower and finisher periods was presented in Table 1. Broilers were provided with continuous light, while temperature was 32°C at the first week then gradually lowered to average 25°C and this temperature was maintained to marketing age. Broilers were vaccinated against Newcastle disease (7 and 14 days); against infectious bronchitis (1 day); and against infectious bursal disease (12 and 18 days).

Table 1: Physical and chemical composition of the diets.

Physical composition (%)	Starter	Grower	Finisher
Yellow corn grain	55.25	64.4	67.05
Soybean meal (48%)	32	17	14.55
Full fat soybean	-	10	12
Corn gluten meal	6	4	2
Soya oil	2.5	1	1
Limestone	1.4	1.2	1.2
Dicalcium phosphate	1.8	1.5	1.3
Salt	0.35	0.3	0.3
Vitamin-mineral premix*	0.3	0.3	0.3
L-lysine	0.25	0.2	0.2
D,L-methionine	0.15	0.1	0.1
Chemical composition			
Metabolizable energy (kcal/kg)	3084	3151	3160
Dry matter %	90.12	90.25	90.28
Crude protein %	22.91	19.94	18.48
Ether extract %	5.11	5.32	5.65
Ash %	7.23	6.54	6.38
Acid detergent fiber %	5.08	5.20	5.21

* Supplied per kilogram of diet: vitamin A, 12000 IU (retinylpalmitate); cholecalciferol, 5000 IU; vitamin E, 60 IU (dl-a-tocopheryl acetate); vitamin K, 3.0 mg; thiamin, 2.0 mg; riboflavin, 8.0 mg; pantothenic acid, 12.0 mg; pyridoxine, 4.0 mg; biotin, 0.2 mg; vitamin B12, 15ug; niacin, 50 mg; choline, 400 mg; folic acid, 2.0 mg; manganese, 100 mg; zinc, 100 mg; copper, 15 mg; iron, 40 mg; and selenium, 0.3mg.

2. Measurements

All broilers were weighed at the beginning and at the end of the experiment. Body weight gain was calculated as the difference between the final and the initial weight. Feed intake was recorded daily and calculated at the end of the experiment. Feed conversion ratio was calculated as feed to gain ratio.

All dead broilers were recorded daily. Broilers dead with SDS were recorded separately from others. Sudden death syndrome was suspected in well grown and healthy-looking broilers, died suddenly with a short terminal wing-beating convulsion or found dead on their backs or breasts. Diagnosis was supported by necropsy findings (a digestive tract filled with ingesta, contracted ventricles, dilated and blood-filled atria, lung congestion, and edema).

At day 33, five broilers were randomly selected from each pen and two blood samples from each were collected from the brachial vein. The first one was collected into heparinized tubes for the determination

of red blood cells (RBCs), white blood cells (WBCs) and packed cell volume (PCV), as indicated by the standard procedures of Jain, (1986). Hemoglobin (Hb) was measured by a colorimetric technique as portrayed by Drabkin and Austin, (1932). The second blood sample was collected into non-heparinized tube which allowed to coagulate at room temperature for 3 h, centrifuged at 3000 rpm for 10 min to obtain sera. Sera samples were stored in Eppendorf vials at – 20 °C for later biochemical analysis.

At the end of the experiment, an estimate was made of the income over feed cost (IOFC) in L.E/chick. This performed by estimation of revenue of average body weight and feeding cost per chick.

3. Laboratory analysis

Samples of starter, grower and finisher diets were ground to pass 1 mm screen (Cyclotec 1093, Foss Sweden). Following (AOAC, 2010) procedures, samples were analyzed for dry matter, ash, crude fat (Soxhlet procedure; method 2003.05) and crude protein (Kjeldahl procedure; method 2001.11). Acid detergent fiber was determined according to the procedure described by (Van Soest *et al.,* 1991) with modifications for use in the ANKOM^{2000}fiber analyzer apparatus (ANKOM Technology Cooperation, Fairport, NY, USA). The values of metabolizable energy were determined according to (NRC, 1994) based on nutrient analyses. Chemical analysis was performed in international accredited (ISO 17025) lab (Feed, Water and Food of Animal Origin Analysis Lab, Veterinary Medicine, Kafrelsheikh University).

4. Biochemical Assays

Serum total protein, albumin and globulin values were determined according toTrinder (1969), serum total cholesterol (Naito and David, 1984), serum level of triglyceride (Fossati and Prencipe, 1982) and serum high density lipoprotein (HDL) (Grove, (1979) utilizing enzymatic packs from Quimica Clinica Aplicada S.A. (Amposta, Spain). Very low density lipoprotein (VLDL) was calculated using the formula of Friedewald *et al.* (1972). The activities of alanine and aspartate aminoaminotransferases (ALT and AST) were assayed by the combined methods of Bergmeyer *et al.* (1976) using commercial assay kits (Diamond Diagnostics, Egypt).

5. Statistical analyses

Statistical analyses were performed by using software package (Minitab 15 Statistical Software English). All data were tested for distribution normality and homogeneity of variance. 2-sample t (test and confidence interval) test was used to compare the differences between groups during study period. A value of $P<0.05$ was considered statistically significant.

RESULTS

The statistical analyses indicated that body weight was significantly decreased in restricted broilers (Table 2). Feed intake was nearly similar in all groups, while feed efficiency was significantly lower in restricted broilers. Restricted broilers showed significant low rates of total mortality and sudden death syndrome (SDS) as shown in Table 2.

Table 2: Effect of early feed restriction on broilers performance and mortality rate (%).

Item	Ad-libitum	Early feed restriction [a]
Initial weight (g)	37.5±0.75	37.2±0.8
Final body weight (g)	1920[a]±50	1730[b]±40
Body weight gain (g)	1882 [a]±48	1693 [b]±39
Feed intake (Kg)	3.32±0.08	3.29±0.09
Feed conversion ratio	1.75[a]±0.2	1.89 [b]±0.3
Total mortality rate (%)	3.86 [a]±0.01	2.9 [b]±0.03
Sudden death syndrome (%)	2.2[a]±0.01	0.72 [b]±0.01

[a] 20% feed restriction between 7-21 days.
Means with different superscript are significantly different ($P<0.05$)

From the economy point of view, restricted broilers showed a significant lower income over feed cost than those fedad libitum (Table 3). The economic difference was due to the lower body weight of restricted broilers at the marketing age.

The present study showed that early feed restriction had no significant effect on serum ALT, AST, proteins, albumin, globulins, HDL, VLDL and cholesterol (Table 4), While, restricted broilers had significantly decreased serum triglycerides and total lipids than those fed ad libitum diet. There was a significant decreased in RBCs and WBCs number, PCV and Hb concentration in restricted broilers (Table 5).

Table 3: Effect of early feed restriction on income over feed cost of broiler chickens (LE/chick).

Item	Ad-libitum	Early feed restriction
Revenue	24.96 [a] ±0.8	22.49[b]±0.7
Feed cost	11.82±0.6	11.71±0.8
IOFC	13.15 [a] ±0.7	10.79 [b] ±0.7
Relative IOFC, %	100 [a] ±5.3	82.05 [b] ±5.3

[a] 20% feed restriction between 7-21 days; IOFC, income over feed cost.
Means with different superscript are significantly different (P<0.05).
Live weight price was 13 LE/kg; mean broiler feed (starter, grower and finisher) price was 3.56 LE/kg.

Table 4: Effect of early feed restriction on serum biochemical parameters of broiler chickens.

Item	Ad-libitum	Early feed restriction[a]
Alanine aminotransferase (u/l)	43.0±6.7	39.57±3.7
Aspartate aminotransferase (u/l)	35.7±3.1	40.84±6.1
Total proteins (g/dl)	4.06±0.52	3.25±0.35
Albumin (g/dl)	1.45±0.19	1.21±0.16
Globulin (g/dl)	2.61±0.47	2.03±0.42
Total lipids (mg/dl)	402.2[a]±6.9	381.1[b]±3.2
Triglycerides (mg/dl)	54.14 [a]±4.2	46.1 [b]±3.7
Cholesterol (mg/dl)	79.59±1.1	78±3.8
High density lipoprotein	39.22±1.8	44.5±4.9
Very low density lipoprotein	12.63±0.61	13.13±0.91

[a] 20% feed restriction between 7-21 days
Means with different superscript are significantly different (P<0.05).

Table 5: Effect of early feed restriction of broiler diet on hematology.

Item	Ad-libitum	Early feed restriction[a]
Hemoglobin (g/dl)	11.26 [a]±0.19	10.1 [b]±0.14
RBCs $*10^6/mm^3$	2.17[a]±0.04	1.97[b]±0.05
TLC$*10^3$/ml	30.8 [a]±1.9	20.52 [b]±1.0
PCV %	35.65 [a]±2.5	28.28 [b]±1.8

[a] 20% feed restriction between 7-21 days; RBCS, red blood corpuscles; TLC, total leukocytes count; PCV, packed cell volume.
Means with different superscript are significantly different (P<0.05).

DISCUSSION

In this study, growth rate could not be sustained with 20% feed restriction as found by Pinchasov and Jensen (1989) who stated that feed restriction can exert negative effects on the body weight at marketing age. Also, Fattori *et al.* (1991) indicated the ineffectiveness of feed restriction in broiler chickens. An experiment conducted by Yu *et al.* (1990) on chicks in which restriction started from 7 to 14 d, reported that after refeeding ad libitum, no compensatory growth was observed. Makinde, (2012) reported that feed restriction negatively affected growth performance as the severity of restriction increased. Recently, Shabani *et al.* (2015) concluded that the feed restriction for 7 or 14 days seemed to be insufficient to markedly improve the feed conversion ratio of broiler chickens at the end of the study (at 42 day of age). On the other hand, Zhan *et al.* (2007) and Onbasilar *et al.* (2009) reported that in re-feeding

period from 22 day of age till the end of the experiments (63 and 42 d, respectively), growth parameters were not statistically significant.

20% feed restriction from 7 to 21 days significantly reduced total mortalities and SDS in broiler chickens. Similarly, Fontana (1992) and Yu (1992) observed that quantitative feed restriction reduced mortality rate in broiler chickens. Also, Bowes *et al.* (1988) showed that 25% feed restriction reduced SDS to 0%, while in ad libitum feeding it was 3.33%. A consistent result of early under-nutrition is reduction in the incidence of metabolic disorders and especially SDS (Leeson and Summers, 2008).

Results of the current study showed an adverse effect of feed restriction on economic return. Similarly, Nwachukwu and Ibe (1990) mentioned that 15% feed restriction had not an economic advantage over ad libitum feeding, while Makinde, (2012) reported that the revenue declined as the period of feed restriction increased. This ascertains the assumption that the faster the growth rate, the better the utilization of feed, since maintenance nutrient needs are minimized (Leeson and Summers, 2008).

Serum total lipids and triglycerides were lower in restricted broilers than those fed ad- libitum. It might be due to the obligate use of considerable levels of triglycerides for energy demand during feed restriction (Demir *et al.*, 2004; Klasing, 1998).

The obtained data of hematology may be revealed to a folic acid deficiency as a result of the feed restriction as monitored by Maxwell *et al.* (1991) who indicated that the decrease in total leukocytes count in the feed-restricted broilers may be associated with a stress response.

In the current study restricted broilers failed to gain a compensatory growth in the re-feeding period (from 22 to 35 days). It might be due to the high maintenance requirements with advanced age. We did not feed broilers after 35 days because as the bird gets older, a greater proportion of nutrients are used for maintenance and less is used for growth. At 5 weeks old, 60% of energy directed to maintenance and 40% to growth requirement (Leeson and Summers, 2008). So, increasing period of feeding beyond 5 weeks decreases efficiency of feed utilization. Although feed restriction decreased mortality rate, it increased FCR leading to high feed cost. Also, this restriction was associated with anemia and low total leukocytes count. Therefore feed restriction is not recommended for the rapidly growing broiler chickens.

CONCLUSION

20% feed restriction from 7 to 21 days of age adversely affected growth performance, blood parameters and income over feed cost. Therefore our results recommended ad libitum feeding for broiler chickens.

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تأثير تقييد العلف على النمو وظاهرة الموت المفاجئ وبعض قياسات الدم في بدارى التسمين

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تهدف هذه الدراسة إلى قياس تأثير تقييد العلف على معدلات النمو وكفاءة التحويل الغائي وأيضا قياس ظاهرة الموت المفاجئ وبعض قياسات الدم في بدارى التسمين. تم تقسيم ١٠٠ كتكوت إلى مجموعتين ثم قسمت كل مجموعة إلى خمس مكررات. تم تقييد العلف في إحدى المجموعات بنسبة ٢٠% في الفترة ٧-٢١ يوم أما المجموعة الأخرى فكانت مجموعة ضابطة أي أن العلف متاح دائما. بدارى التسمين متاحة العلف حصلت على معدلات أعلى في النمو وكفاءة التحويل الغذائي بالمقارنة مع المجموعة مقيدة العلف. على الرغم من أن معدل الوفيات كان أعلى في بداري التسمين متاحة العلف إلا أن كفاءة التحويل الغذائي أدت إلى زيادة الدخل فوق تكلفة العلف.تقييد العلف أدى إلى ظهور أنيميا نتيجة قلة عدد كرات الدم الحمراء وأيضا أدى إلى تقليل عدد كرات الدم البيضاء مما يدل على أنه يعتبر احد الضغوط على بداري التسمين. تقييد العلف له تأثير سلبي على معدلات النمو وكفاءة التحويل الغذائي والربح. ولذلك توصي هذه الدراسة بإتاحة العلف دائما لدجاج بداري التسمين.