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Effect of Feed Withdrawal on Growth Performance and Carcass Characteristics of Heat Stressed Broiler Chicken

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Abstract: An experiment was conducted to study the effect of feed withdrawal at different ages during the hottest summer days on the growth performance and some carcass traits of broiler chicken. One hundred thirty five male chicks at 14 days of age (DOA) with average body weight (375 g/bird) were randomly allotted to three treatments with three replicates each. The treatments consisted of the control (no feed withdrawal), early feed withdrawal (EFW) at the fourth week of age and late feed withdrawal (LFW) at the fifth week of age. The treatments were assigned to a completely randomized design. The experiment lasted for five weeks having one week as a transitional period, and it was terminated at 49 DOA. The feed withdrawal duration was two weeks for each group. Feed withdrawal was undertaken from 10:00 am till 7:00 pm. Feed intake and live body weight were recorded weekly. Feed conversion ratio (FCR) and the cumulative mortality rate were calculated. Some physical and chemical analyses were carried out for some carcass parts (drumstick and thigh). The abdominal fat pad (AFP) was removed and weighed. The LFW group significantly ($P \leq 0.05$) consumed the highest amount of feed, whereas the EFW group consumed the least amount. The cumulative mortality rate was significantly ($P \leq 0.05$) lower for LFW and EFW, and the control group recorded the highest rate. At 49 DOA, live body weight was significantly ($P \leq 0.05$) the highest for the LFW group, whereas the other groups recorded similar body weights. The overall FCR was significantly ($P \leq 0.05$) the best for LFW group, whereas the control had

the worst FCR. The control group significant ($P \leq 0.05$) recorded the highest carcass fat percentage and AFP weight, followed by EFW and LFW, respectively. Feed withdrawal during the hottest hours of summer can be recommended as a good practice in reducing the negative effects of heat stress on broiler chickens, starting at 29 day of age.

Key words: Broiler; heat stress; feed withdrawal; feed consumption and conversion.

INTRODUCTION

The high growth rate of broiler chickens causes stress on birds leading to metabolic diseases and skeletal disorders. As a result, economic losses due to reduced animal performance, high mortality rates and carcass condemnation at slaughter houses are observed (Cuddington 2004).

The expression of heat stress in poultry production can be described as acute heat stress, which refers to short and sudden periods of extremely high temperature, or chronic heat stress that refers to extended periods of elevated temperature (Emery 2004). It has been shown that heat stress has detrimental effects on the performance of 4-8 week old broiler chickens reared in open-sided poultry houses and negatively affects feed efficiency and carcass quality as well as health (Oskan *et al.* 2003). Moreover, chronic heat stress increases the time to reach market weight and increases mortality rate (Ozbey and Ozcelik 2004).

Various methods of under nutrition have been used to retard or even stop growth during the restriction period. These methods include the following:

(1) Physical feed restriction: It provides a calculated quantity of feed per bird, and has a constraint due to the need to weigh feed on a daily basis (Sayda and Hyder 2006a).

(2) Skip-a-day feeding programmemes: These are widely used in broiler breeder's growth restriction programmes as a technique for limiting early growth, but it has not been extensively examined for broiler chickens (Dozier *et al.* 2002).

(3) Feed withdrawal during hot hours of the day: This may be a choice to reduce the effect of broiling temperature during summer. Using feed removal results in significantly decreased body weight with better feed conversion ratio in groups with six hours feed removal (Petek 2000).

(4) Lighting manipulation: It was reported by Olanrewaju *et al.* (2006) that short photoperiods during early life of broiler chickens reduces feed intake and limits growth.

(5) Diet dilution: It is an alternative and qualitative method of nutrient restriction because of the advantage of attaining a more consistent growth pattern within a flock (Rezaei *et al* 2006; Sayda and Hyder 2006b).

Feeding management of broilers to be deprived from feed during the hottest hours of the day in summer months may help resist heat stress. In subtropical areas, time limit feeding during cool hours is a common practice for combating heat stress. Little work concerning feed withdrawal during different ages of broiler chickens was undertaken in Sudan. The general objective of this experiment was to study the effect of feed withdrawal during day-time on performance of broiler chickens, with the following specific objectives:

1. To examine the effect of feed withdrawal on growth performance and carcass characteristics of heat- stressed broiler chicken

2. Find the best age for feed withdrawal during summer

MATERIALS AND METHODS

This experiment was carried out at south Wad Medani town, Gezira State in Central Sudan, to study the effect of feed withdrawal during the hottest hours of the day of summer on the performance of broiler chickens. It was undertaken during 16th May to the 13th June 2010. The prevailing temperature ranged from 26°C to 33°C at night and from 36°C to 44°C at day time.

A total of 135 14-day old broiler chicks (Cobb strain) were divided randomly into nine groups, with 15 birds in each. The groups were randomly assigned to three treatments with three replicates each. They were randomly distributed to nine experimental pens (2 x 1.5 m^2) placed inside an open-sided poultry house. Each pen was provided with water and feed troughs.

The experimental diets were formulated (Table 1) according to the nutrient requirements of broiler chickens as outlined by the NRC (1994). The birds were fed according to the experimental feeding programme as follows:

(1) The control birds were fed a balanced broiler starter diet *ad libitum* and finisher diets *ad libitum* till the end of the experiment at 49 day of age (DOA).

(2) For early feed withdrawal, the birds were fed on a starter diet *ad libitum* during the first 21 days of age and were then fed a finisher diet (22- 49 DOA). During this phase, they were subjected to feed removal from 10: 00 to 19: 00 during the fourth and fifth weeks of age (22 – 35 DOA). Thereafter, feed was provided *ad libitum* until the end of the experiment (49 DOA).

(3) For late feed withdrawal, the birds were fed on a starter diet *ad libitum* during the first 21 days of age and were then fed a finisher diet. They were then subjected to feed withdrawal from 10: 00 to 19: 00 during the fifth and the sixth weeks (29 – 42 DOA). Thereafter, feed was provided *ad libitum* until the end of the experiment (49 DOA).

Table 1. Ingredient and chemical composition of starter and finisher diets

	Diets	
	Starter	Finisher
Ingredient (%)		
Sorghum grain	67.0	69.0
Groundnut cake	24.8	20.8
Super concentrate *	5.0	5.0
Groundnut oil	1.0	3.0
Bromix **	0.5	0.5
Oyster shell	0.8	0.8
Choline chloride	0.2	0.2
Protect program	0.2	0.2
Anti bacterial powder	0.1	0.1
Anti toxic and fungal powder	0.2	0.2
Salt	0.2	0.2
Total	100.0	100.0
Calculated chemical composition		
Dry matter (DM) (%)	94.1	93.9
Crude protein (CP) (%)	21.8	20.2
Ether extract (EE) (%)	4.8	6.5
Crude fibre (CF) (%)	4.2	3.9
Ash (%)	5.6	5.4
Nitrogen free extract (%)	57.7	57.9
Calcium (Ca) (%)	1.0	1.0
Phosphorus available (Pav.) (%)	0.44	0.43
Metabolisable energy (ME) kcal/kg***	3086	3208

* Super concentrate contained the following: 35% CP, 2% EE, 4% CF, 10% calcium, 4.5% available phosphorus, 5.7% lysine, 4.5% methionine and 4.9% methionine + cystine. Metabolisable energy 2000 kcal/kg, 2.6% sodium with added vitamins and minerals.

** Broiler mixture containing multivitamins, trace elements and antioxidants.

*** Metabolisable energy (ME Kcal/kg) was calculated according to the formula derived by Lodhi *et al.* (1976). ME kcal/kg = 32·95 (% crude protein + % ether extract × 2·25 + % available carbohydrate) –29·20.

Data on feed consumption and live body weight were collected on weekly basis. Feed conversion ratio (FCR) was calculated on weekly basis and as overall. After slaughter, data were also collected on external and internal organs weights, carcass cuts and meat chemical analysis.

At the end of the experiment, the live body weight of the experimental birds was taken individually. Six birds were selected from each replicate and were slaughtered for further studies. The birds were slaughtered according to the Islamic traditions by severing the jugular veins, trachea and the oesophagus. Some carcass traits (right leg thigh and drumstick) were removed and kept for further analyses which involved chemical analysis. The muscles were stripped of the bone of the thigh, minced and a proximate analysis was done for the moisture, ash and fat contents. The thigh and drum stick bones dry matter and ash were determined.

Statistical analysis

Statistical analysis was done using MSTAT (Russel and Eisensmith 1983). Analysis of variance was done as described by Steel *et al*. (1996). A completely randomized design was used to analyze the data. Duncan (1955) multiple range tests were used to determine the differences among the treatments means.

RESULT S AND DISSCUTION

Feed consumed during the first week of the experiment (fourth week of age) was significantly ($P \leq 0.05$) affected by the age at which feed withdrawal was inflicted (Table 2). The early feed withdrawal group consumed significantly ($P \leq 0.05$) the highest amount of feed. However, during the fifth week of age (second week of the experiment), there was insignificant ($P > 0.05$) difference among the different treatment groups. During the sixth week of age there were significant ($P \leq 0.05$) differences among the different treatment groups, whereas the control group consumed the highest amount of feed (Table 2). This result might be attributed to the fact that the control and early feed withdrawal groups were fed *ad libitum* during this week and had access to feed during the whole day. Reduced feed intake due to feed restriction had also been observed under Sudan conditions (Sayda and Hyder 2006b; Yagoub and

Salih 2008). However, during the seventh week of age there were insignificant ($P > 0.05$) differences in feed intake. These results might be attributed to the fact that all groups were fed *ad libitum* and the late feed withdrawal group was compensating during this week after two weeks of feed withdrawal. Nevertheless, there were significant ($P \leq 0.05$) differences in the overall feed intake among the different treatment groups, whereas, the late feed withdrawal group consumed the highest amount of feed and the early feed withdrawal groups consumed the smallest amount (Table 2).

During the fourth, fifth and sixth weeks of age (first, second and third weeks of the experiment), there were insignificant ($P>0.05$) differences in body weight. The late feed withdrawal group had slightly the heaviest live body weights followed by the early feed withdrawal group (Table 2). During the seventh week of age, there was a significant ($P \leq 0.05$) difference in live body weight, whereas the late feed withdrawal group had the heaviest live body weight, followed by the early feed withdrawal group. The heavier body weight of the birds subjected to late feed withdrawal and early feed withdrawal, compared to the control group, maybe attributed to the fact that these groups fed during the cool hours of the day, had less metabolic heat production and thus more energy was retained for growth. These results are in accord with those of Zulkifli *et al.* (2000). Another explanation maybe that the feeding management of broiler chickens, which were deprived from feed during the hottest hours of the day, may help the birds to resist heat stress. These findings confirm that of Francis *et al.* (1991), who reported that depriving birds from feed during the hottest hours of the day may help the birds to resist heat stress. This is because of the easier regulation against the expected rise in their body temperature due to discontinuation of further heat production during that critical period.

Feed conversion ratio (FCR) of the group of birds subjected to early feed withdrawal during the first week of the experiment (fourth week of age) had significantly ($P \leq 0.001$) the worst FCR (Table 2). This may be attributed to the fact that these birds consumed the highest amount of feed compared to other groups. During the second week of the experiment

(fifth week of age), the early feed withdrawal group had significantly ($P \leq 0.05$) the best FCR, followed by the late feed withdrawal group, while the control group showed the worst FCR. This could be attributed to the fact that the early feed withdrawal group undergone compensation during this week. It maybe as well due to the fact that the late feed withdrawal group deprived from feed during that week, had access to feed during night consuming less feed to maintain body temperature. However, during the second week there was a tremendous increment in the temperature during day and night resulting in a decreased feed intake by all groups (Table 2). During the third week of the experiment, the late feed withdrawal group had significantly ($P \leq 0.001$) the best FCR followed by early feed withdrawal group, whereas the control group had the worst FCR.

Nevertheless, during the last week of the experiment (seventh week of age) the late feed withdrawal group had significantly ($P \leq 0.001$) the best FCR, while the control group had the worst. The overall or cumulative FCR, as shown in Table 2, was significantly ($P \leq 0.001$) the best for the late feed withdrawal, followed by the early feed withdrawal group, while the control had the worst FCR. These findings suggest that the age at which feed withdrawal had been undertaken affected the efficiency of feed utilization by the birds. The best FCR was obtained in the birds subjected to feed withdrawal at older age (29-42 day of age) compared with early feed withdrawal and those fed *ad libitum* throughout the experiment. The efficient feed utilization of the birds subjected to feed restriction may be attributed to the reduced heat stress during the hottest hours of the day, resulting in reduced metabolic heat production and thus reduced the stress upon the birds. Moreover, feed withdrawal reduces the body temperature of broilers during summer days (Anjum 2000).

Table 2. Effect of feed withdrawal during summer day-time on weekly feed intake, body weight (g) and feed conversion ratio of broiler chicken

Age	Treatments			C.V. (%)
	Control	EFW	LFW	
	Weekly feed intake (g)			
Week four	638b	688a	646b	1.32
Week five	742a	714a	731a	2.29
Week six	815a	806a	761b	2.64
Week seven	835a	829a	849a	2.01
Cumulative feed Intake	3020a	2988b	3038a	1.89
	Weekly body weight (g)			
Week three	623a	645a	629a	3.63
Week four	997a	986a	1000a	1.14
Week five	1390a	1383a	1393a	1.55
Week six	1775a	1781a	1803a	1.80
Week seven	2120b	2167ab	2217a	1.84
	Feed conversion ratio			
Week four	1.78b	1.99a	1.79b	0.88
Week five	1.89a	1.80c	1.86b	0.60
Week six	2.11a	2.03b	1.87c	0.58
Week seven	2.42a	2.15b	2.06c	0.62
Cumulative FCR	2.04a	1.99b	1.89c	0.56

Means in the same row followed by the same letter are not significantly different at P=0.05 according to Duncan's Multiple Range Test (1955).

EFW: Early feed withdrawal; LFW: Late feed withdrawal; C.V.: Coefficient of variation

As shown on Table 3, there were insignificant ($P > 0.05$) differences in the moisture and ash contents of the carcass parts (Thigh and drumstick muscles). However, the control group had significantly ($P \leq 0.01$) the highest fat content compared with the restricted groups (early feed withdrawal and late feed withdrawal groups). This result may be attributed to the fact that the control group was subjected to continuous feeding which enabled the birds to synthesize and deposit the excess energy in the form of fat without being retrieved. In the case of feed withdrawal, the birds may need to retrieve the stored energy in the form of fat during the restriction period. As a result, the feed withdrawal groups end up with less fat in their bodies. These findings are in line with the findings of Ali *et al.* (2013). However, the moisture and the ash contents of the thigh and the drumstick bones were insignificantly ($P > 0.05$) affected by feed withdrawal (Table 3).

There were insignificant ($P > 0.05$) differences in moisture and ash contents of drumstick and thigh bones (Table 3). These organs grew at higher rates at early stages of growth; this was why they were not affected by feed withdrawal that started at the fourth and fifth weeks of age. These findings support that of Tesfaye *et al.* (2009) who reported an insignificant effect of feeding regimen on weight of legs. They also suggested that the feed restriction at middle age (fourth and fifth weeks of age) may be considered beneficial in terms of carcass cut characteristics and economic return.

The gastrointestinal tract, as measured by the small intestine weight (Table 3), was insignificantly ($P > 0.05$) affected by feed withdrawal. Being the nutrient supply system, it has the priority for growth during early post hatching periods. These results support that of Ali *et al.* (2007) who indicated that the gastrointestinal organs grew at a higher rate during early stages of growth having the priority of growth compared to the other tissues (bones, muscles and adipose tissue). This is because they are the supporting and mediating organs for digestion and absorption of the ingested nutrients since early age. As shown in Table 3, the control group had significantly ($P \leq 0.05$) the heaviest AFP weight, whereas the late feed withdrawal group had the lowest AFP. These results are in line with that of Ali *et al.* (2007) and Zhan *et al.* (2007).

Table 3. Effect of feed withdrawal during summer-day time on some carcass characteristics of some parts of broiler chickens

Parameters	Treatments			C.V%
	Control	EFW	LFW	
Muscle moisture content (%)	73.6a	74.3a	71.9a	1.71
Muscle fat (%)	8.9a	7.8b	7.5b	3.99
Muscle ash (%)	1.12a	1.08a	1.1a	2.22
Drumstick bone moisture (%)	51.8a	52.6a	51.9a	4.38
Drumstick bone ash (%)	16.0a	15.0a	16.0a	7.6
Thigh bone moisture (%)	60.3a	61.7a	60.33a	3.44
Thigh bone ash (%)	15.7a	14.0a	15.3a	5.06
Abdominal fat pad weight(g)	57.7a	33.3b	28.8b	10.14
Small intestine weight(g)	95.0a	90.7a	90.5a	3.9

Means in the same row followed by the same letter are not significantly different at P=0.05 according to Duncan's Multiple Range Test (1955).

EFW: Early feed withdrawal; LFW: Late feed withdrawal; C.V.: Coefficient of variation

The mortality rate of the birds during the first week of the experiment was insignificantly ($P > 0.05$) affected by feed withdrawal (Table 4). However, during the second and the third weeks the control group had significantly ($P \leq 0.05$) the highest mortality rate. The cumulative mortality rate, as shown in Table 4, was significantly ($P \leq 0.01$) the highest for the control group. These results indicate that feed withdrawal during the hottest hours of the day helped in reducing the mortality rate of the birds. These findings are in accord with previous authors (Zulkifli *et al.* 2000; Underneta-Rincon and Leeson 2002; Mahmood *et al*. 2005; Ali *et al.* 2007), who reported significant positive effect of feed restriction on survivability in heat stressed broiler chickens.

It is concluded that feed withdrawal during the hottest hours of summer days is a good management practice as it increases the efficiency of feed utilization and reduces the mortality rate of the birds. Late feed withdrawal at the fifth week of age is relatively better than early withdrawal at the 4^{th} week of age. Feed withdrawal reduces carcass fat and abdominal fat pad resulting in heavier carcass weight.

It can be recommended that the adoption of feed withdrawal during the hottest hours of summer may help in solving the problems of heat stress and in reducing mortality rate.

Table 4. Effect of feed withdrawal during summer-day time on mortality rate of broiler chickens

Mortality (%)	Treatments			
	Control	EFW	LFW	C.V%
Week 4	6.7a	4.5a	2.2a	39.8
Week 5	14.1a	0.0b	4.4b	37.7
Week 6	7.9a	0.0b	0.0a	18.6
Week 7	0.0b	5.7a	0.0b	75.5
Cumulative mortality (%)	26.3a	8.9a	6.7a	29.9

Means in the same row followed by the same letter are not significantly different at P=0.05 according to Duncan's Multiple Range Test (1955).

EFW: Early feed withdrawal; LFW: Late feed withdrawal; C.V.: Coefficient of variation

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تأثير سحب الغذاء علي أداء وخصائص الذبيحة لفراخ اللحم المُجْهد حرارياً

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المستخلص: أجريت تجربة لدراسة تأثير سحب الغذاء في أعمار مختلفة أثناء ساعات نهار الصيف علي الأداء العام وبعض صفات الذبيحة لفراخ اللحم. تم إختيار 135 كتكوتاً ذكراً عمر 14 يوم. قُسمت الكتاكيت إلي 9 مجموعات متساوية من 15 كتكوتاً تم توزيعها عشوائياً لثلاث معاملات بثلاثة تكرارات . إحتوت المعاملات علي الشاهد (بدون سحب للغذاء)، وسحب الغذاء المبكر في عمر22 يوماً، وسحب الغذاء المتأخر في عمر29 يوما، وذلك بإستخدام التصميم العشوائي الكامل. إستمرت التجربة لمدة أربعة أسابيع وكانت فترة السحب لكل مجموعة إسبوعين و سُحب الغذاء من الساعة العاشرة صباحاً وحتي الساعة السابعة مساءاً. رُصدت كمية الغذاء المتناول وأوزان الفراخ إسبوعياً ومن ثمَ حُسبت الكفاءة التحويلية للعلف، كما رُصد النفوق لكل معاملة. و أُجريت بعض التحاليل الفيزيائية والكيميائية لبعض أجزاء الذبيحة (الساق والفخذ). أُزيلت الوسادة الدهنية البطنية ووُزنت. أظهرت النتائج فروقات معنوية في كمية الغذاء المتناول حيث تناولت مجموعة السحب المتأخر أكبر كمية من الغذاء ومجموعة السحب المبكر أقل كمية. كان معدل النفوق التراكمي الأقل لكلٍ من مجموعتي السحب المبكر والمتأخر بينما كان عالياً في مجموعة الشاهد. كذلك وُجدت فروقات معنوية للأوزان النهائية للفراخ حيث كانت أوزان مجموعة السحب المتأخر هي الأعلي تليها مجموعة السحب المبكر والشاهد علي التوالي. ووُجدت فروقات معنوية في الكفاءة التحويلية للعلف، و كانت مجموعة السحب المتأخر هي الأفضل والشاهد الأسوأ. كذلك وُجدت فروقات معنوية في محتوي الدهن في الذبيحة ووزن الوسادة الدهنية البطنية و سجل الشاهد أعلي نسبة، بينما سجلت مجموعة السحب المبكر أقل نسبة. يوصي بإستخدام برنامج سحب الغذاء من فراخ اللحم أثناء ساعات نهار الصيف إبتداءاً من عمر 29 يوماً.