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Effect of Sex, Level and Period of Feed Restriction During the Starter Stage on Productivity and Carcass Characteristics of Ross 308 Broiler Chickens in South Africa

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Abstract: The effects of sex, level and period of feed restriction during the starter period on productivity and carcass characteristics of Ross 308 broiler chickens were evaluated. A 2 (male and female chickens) x 3 (feeding levels: *Ad-libitum,* 75% and 50% of *ad libitum*) x 3 (restriction periods of 5, 7 and 9 days) factorial arrangement in a complete randomized design was used. The effects of interactions were not included in the results because earlier analyses including all the interactions showed that they were not important. Level and period of feed restriction during the starter stage had an effect ($P<0.05$) on live weight of the chickens at 21 days of age. Chickens on 75% *ad libitum* feeding attained complete live weight compensation with those on *ad-libitum* feeding at the age of 42 days. However, chickens on 50% *ad libitum* feeding did not 'catch-up' with those on *ad libitum* feeding. Differences due to the period of feed restriction during the starter stage were maintained up to the age of 42 days. Male chickens had higher ($P<0.05$) live weights at 42 days of age. Abdominal fat pad was not affected ($P>0.05$) by level and period of feed restriction and sex of chickens at 42 days of age.

Key words: Ross 308 broiler chickens, Starter stage feed restriction, carcass characteristics, South Africa

Introduction

Poultry production can play an important role in poverty alleviation and in the supply of quality protein to rural people (Pedersen, 1998). The high demand for chicken meat, low capital input required, early market age, rapid return over invested capital and the small space required for poultry production have increased awareness that chicken farming is a profitable venture in the Limpopo province. However, high fat deposition in broiler chickens does affect the industry (Zubair and Leeson, 1996). Allowing birds an unlimited supply of food results in consumption in excess of the bird's requirements for maintenance and production and the excess energy is converted into fat (Fontana *et al.,* 1992; Cuddington, 2004). Excessive fat is one of the main problems faced by the broiler industry these days, since it not only reduces carcass yield and feed efficiency but also causes rejection of the meat by consumers (Kessler *et al.,* 2000) and causes difficulties in processing (Chambers, 1990). Recent reports on food restriction during the growing period in broiler chickens indicate that restricting food intake lowers body weight and carcass fat and improves food efficiency with compensatory growth during refeeding (Plavnik *et al.,* 1986; Fontana *et al.,* 1992; Al-Taleb, 2003). However, contrary results have also been reported elsewhere (Summers *et al.,* 1990; Leeson *et al.,* 1991; Robinson *et al.,* 1992). Broiler chickens undergoing compensatory growth, also, exhibit greater than normal feed intake relative to body weight and may exhibit some associated digestive adaptations (Zubair and Leeson, 1994b). The use of this concept to address problems of high carcass fat requires more studies on the nutrition of the broiler chicken during the period of growth compensation. The main objective of this study was to determine the effect of sex, level and period of feed restriction during the starter stage on productivity and carcass characteristics of Ross 308 broiler chickens in South Africa.

Materials and Methods

Study site: This study was conducted in 2007 in an open-sided house with curtains at the Experimental farm of the University of Limpopo, Limpopo Province, South Africa. The farm is located at about 10 km northwest of the University campus. The ambient temperatures around the study area are above 32°C during summer and around 25°C or lower during the winter season. The mean annual rainfall is between 446.8 and 468.4 mm.

Birds, treatments, design and data collection: Male and female Ross 308 broiler chickens were raised for 12 days before the commencement of the study. On commencement, 540 male and female Ross 308 broiler chickens were allocated to 18 treatments (Table 1) with three replications in a 2(sexes of chickens) x 3(feeding regimes: *Ad libitum* feed as the control, 75 % *ad libitum* i.e. (75 % of amount of feed intake of *ad libitum* chickens of the previous day, and 50 % *ad libitum*) x 3(restriction periods of 5, 7 and 9 days) factorial arrangement in a completely randomised design (SAS, 2000). Ten birds were used in each replication. Re-alimentation period

Table 1: Experimental treatments

Treatments		
SMR_0P_5	:	Male chickens without any starter feed restriction
SMR_0P_7	:	Male chickens without any starter feed restriction
SMR_0P_9	:	Male chickens without any starter feed restriction
$SMR_{75}P_5$	:	Male chickens fed 75 % *ad-libitum* starter intake for five days
$SMR_{75}P_7$	:	Male chickens fed 75 % *ad-libitum* starter intake for seven days
$SMR_{75}P_9$	:	Male chickens fed 75 % *ad-libitum* starter intake for nine days
$SMR_{50}P_5$	:	Male chickens fed 50 % *ad-libitum* starter intake for five days
$SMR_{50}P_7$	:	Male chickens fed 50 % *ad-libitum* starter intake for seven days
$SMR_{50}P_9$	:	Male chickens fed 50 % *ad-libitum* starter intake for nine days
SFR_0P_5	:	Female chickens without any starter feed restriction
SFR_0P_7	:	Female chickens without any starter feed restriction
SFR_0P_9	:	Female chickens without any starter feed restriction
$SFR_{75}P_5$	:	Female chickens fed 75 % *ad-libitum* starter intake for five days
$SFR_{75}P_7$	:	Female chickens fed 75 % *ad-libitum* starter intake for seven days
$SFR_{75}P_9$	:	Female chickens fed 75 % *ad-libitum* starter intake for nine days
$SFR_{50}P_5$	:	Female chickens fed 50 % *ad-libitum* starter intake for five days
$SFR_{50}P_7$	:	Female chickens fed 50 % *ad-libitum* starter intake for seven days
$SFR_{50}P_9$	:	Female chickens fed 50 % *ad-libitum* starter intake for nine days

was from day 22 until day 42. Diets were isocaloric and isonitrogenous. The birds were offered feed and fresh water *ad-libitum*. The lighting programme was 24 hours. The experiment was terminated when the birds were 42 days of age. During the experiment, the initial average live weights of the chickens were taken at 12 days old. Thereafter, daily mean live weights and feed intake were measured until the end of the experiment at 42 days. Daily growth rates and feed conversion ratio were calculated. Mortality was measured throughout the experiment. At Day 36, four birds were randomly selected from each replication and transferred to metabolic cages for measurement of apparent digestibility. At 42 days old, all remaining birds were slaughtered by cervical dislocation to determine the carcass characteristics.

Nutrient analysis: The dry matter, nitrogen, crude protein, phosphorus and fat contents were determined as described by AOAC (2000). The gross energy (GE) of the diets and excreta samples were determined using an adiabatic bomb calorimeter (University of Kwazulu-Natal Laboratory, South Africa). The apparent metabolizable energy (AME) content of the diets was calculated (AOAC, 2000).

Data analysis: Effect of sex, level and period of feed restriction during the starter stage on live weight, feed intake, feed conversion ratio, digestibility, carcass characteristics and mortality were analyzed using the General Linear Models (GLM) procedures of statistical analysis of variance (SAS, 2000). Means were separated using Duncan's multiple-range test (Duncan, 1955). The effects of interactions were not included in the model because earlier analyses including all the interactions showed that they were not important.

Results

The nutrient compositions of the starter and grower diets are presented in Table 2. The diets at each phase (i.e. starter and grower phases) were isocaloric and isonitrigenous and met the requirements for broiler chickens as recommended by the NRC (1994).

The effect of sex, level and period of feed restriction on live weight at 21 days of age, feed intake, feed conversion ratio and mortality of Ross 308 broiler chickens between 12 and 21 days of age are presented in Table 3. Male and female broiler chickens had similar ($P>0.05$) live weights and mortality rates. However, female chickens had lower ($P<0.05$) feed intakes and better feed conversion ratio than male chickens. Level of feed restriction had effect ($P<0.05$) on feed intake, live weight and feed conversion ratio. However, level of feed restriction had no effect ($P>0.05$) on mortality. Period of feed restriction had no effect ($P>0.05$) on feed conversion ratio. Broiler chickens on 9 days of feed restriction had lower ($P<0.05$) live weights and feed intakes than those on 5 days of feed restriction. However, broiler chickens on 5 days of feed restriction had live weights and feed intakes similar ($P>0.05$) to those on 7 days of feed restriction. Similarly, broiler chickens on 7 days of feed restriction had live weights and feed intakes similar ($P>0.05$) to those on 9 days of feed restriction. Broiler chickens on 7 days of feed restriction had higher ($P<0.05$) mortality rates than those on 5 and 9 days of feed restriction. However, broiler chickens on 5 and 9 days of feed restriction had similar ($P>0.05$) mortality rates.

Results of the effect of sex, level and period of feed restriction on dressing percentage and carcass characteristics at 21 days of age are presented in Table 4. Male and female chickens had similar ($P>0.05$) live weight, dressing percentage, fat pad weight, gizzard

Table 2: Nutrient composition of the starter and grower diets (the units are in g/kg for dry matter, g/kg DM for protein, lysine, fat, calcium and phosphorous and MJ ME/kg DM for energy)

	Nutrient						
Diet	Dry matter	Energy	Protein	Lysine	Fat	Calcium	Phos-phorus
Starter	880	16.4	233.0	11.0	25	12	6.0
Grower	880	15.5	198.8	11.5	25	10	5.5

Table 3: Effect of sex, level and period of feed restriction on live weight and intake at 21 days of age, feed conversion ratio (FCR) and mortality (%) of Ross 308 broiler chickens between 12 and 21 days of age

		Variable			
Treatment	No	Live weight (g)	Intake (g/bird /day)	FCR (gfeed/g lwt gain)	Mortality (%)
Restriction					
0 % *ad-libitum*	180	692.50[a]	101.53[a]	2.29[a]	0.00[a]
75 % *ad-libitum*	180	640.83[b]	72.87[b]	1.81[b]	0.56[a]
50 % *ad-libitum*	180	531.11[c]	48.80[c]	1.74[b]	1.11[a]
SE		13.41	0.860	0.07	0.52
Period					
5	180	640.00[a]	75.65[a]	1.89[a]	0.00[b]
7	180	625.83[ab]	74.70[ab]	1.96[a]	1.67[a]
9	180	598.61[b]	72.85[b]	2.00[a]	0.00[b]
SE		13.41	0.860	0.07	0.52
Sex					
Male	270	628.33[a]	77.15[a]	2.07[a]	0.37[a]
Female	270	614.63[a]	71.65[a]	1.83[b]	0.74[a]
SE		10.95	0.700	0.06	0.43

[a,b,c]Means in the same column not sharing common superscript are significantly. different (P<0.05). SE:Standard error. lwt gain: Live weight gain

weight, liver weight and intestine lengths at 21 days of age. Level of feed restriction had no effect (P>0.05) on dressing percentage, gizzard and liver weights of broiler chickens. Broiler chickens on 75 and 50% *ad-libitum* feeding had similar (P>0.05) intestine lengths and fat pad weights. Broiler chickens on 50% *ad-libitum* feeding had lower (P<0.05) fat pad weights than those on *ad-libitum* feeding. However, chickens on 75% *ad-libitum* feeding and those on *ad-libitum* feeding had similar (P>0.05) fat pad weights at 21 days of age. Period of feed restriction had no effect (P>0.05) on dressing percentage, fat pad weight, gizzard weight, liver weight and intestine length of broiler chickens.

Results of the effects of sex, level and period of feed restriction at the starter stage on feed intake, intake as percentage of live weight, growth rate, feed conversion ratio and mortality of broiler chickens between 22 and 42 days of age are presented in Table 5. Male broiler chickens had higher (P<0.05) feed intake expressed as percentage of live weight, growth rate and better feed conversion ratio than female chickens. When intake was expressed as percentage of live weight, chickens on 75 and 50% *ad-libitum* feeding had similar (P>0.05) feed intake. However, level of feed restriction had no effect (P>0.05) on feed intake, growth rate and mortality of broiler chickens between 22 and 42 days of age. Broiler chickens on *ad-libitum* feeding and those on 50% *ad-libitum* feeding had similar (P>0.05) feed conversion ratio between 22 and 42 days of age. However, broiler chickens on 75% *ad-libitum* feeding had a poorer (P<0.05) feed conversion ratio than those on *ad-libitum* feeding and those on 50% *ad-libitum* feeding. Period of feed restriction had no effect (P>0.05) on feed intake, growth rate, feed conversion ratio and mortality of broiler chickens between 22 and 42 days of age.

Apparent dry matter digestibility, nitrogen digestibility, nitrogen retention and metabolisable energy of broiler chickens between 40 and 42 days of age are shown in Table 6. Sex and period of feed restriction at the starter stage had no effect (P>0.05) on apparent dry matter and nitrogen digestibilities, nitrogen retention and metabolisable energy of the birds between 40 and 42 days of age. Level of feed restriction had no effect (P>0.05) on apparent dry matter digestibility. However, chickens on 75 and 50% *ad-libitum* feeding had higher (P<0.05) nitrogen digestibility and nitrogen retention values than those on *ad-libitum* feeding. Broiler chickens on 75 and 50% *ad- libitum* feeding had similar (P>0.05) nitrogen digestibility, nitrogen retention and metabolisable energy values. However, broiler chickens on 75% *ad-libitum* feeding had higher (P<0.05) metabolisable energy values than those on *ad-libitum* feeding while birds on *ad-libitum* feeding and 50% *ad-libitum* feeding had similar (P>0.05) metabolisable energy values.

The effects of sex, level and period of feed restriction on parts when expressed as percentage of carcass weight of Ross 308 broiler chickens at 42 days of age are presented in Table 7. Male and female broiler chickens had similar (P>0.05) dressing percentage and fat pad weight. However, female chickens had lower (P<0.05) live weights, thigh, drumstick, wing, breast, gizzard, liver weights and intestine lengths than male chickens. Level of feed restriction had no effect (P>0.05) on fat pad, gizzard, liver weights and intestine lengths of broiler chickens at 42 days of age. However, level of feed restriction affected (P<0.05) live weight, dressing percentage, thigh, drumstick, wing and breast meat weights of broiler chickens. Broiler chickens on 50% *ad-libitum* feeding had lower (P<0.05) live weight, dressing percentage, weights of thigh, drumstick, wings and breast meat than those on *ad-libitum* feeding. However, chickens on 75% *ad-libitum* feeding and those on 50% ad- libitum feeding had similar (P>0.05) live weight, dressing percentage, weights of thigh and breast meat. Broiler chickens on 50% *ad-libitum* feeding had lower (P<0.05) drumstick and wing weights than those fed *ad-libitum* and 75% *ad-libitum* feeding. Period of feed restriction had no effect (P>0.05) on dressing percentage, thigh, drumstick, wing, fat pad, gizzard and liver weights and intestine lengths of broiler chickens at 42 days of age. However, broiler chickens on 5 days of feed restriction had similar (P>0.05) live weights and

Table 4: Effect of sex, level and period of feed restriction on dressing percentage and carcass characteristics of Ross 308 broiler chickens at 21 days of age

		Variable				
Treatment	No	Dressing Percentage (%)	Fat (g)	Gizzard (g)	Liver (g)	Intestinal Length (cm)
Restriction						
0 % *ad-libitum*	180	87.15^{a}	2.78^{a}	17.98^{a}	20.28^{a}	167.11^{a}
75 % *ad-libitum*	180	86.96^{a}	2.25^{ab}	17.31^{a}	20.66^{a}	154.44^{b}
50 % *ad-libitum*	180	84.17^{a}	1.85^{b}	16.76^{a}	18.94^{a}	154.83^{b}
SE		1.02	0.27	0.59	1.54	3.62
Period						
5	180	86.42^{a}	2.62^{a}	18.14^{a}	20.93^{a}	161.38^{a}
7	180	87.09^{a}	2.08^{a}	17.04^{a}	20.42^{a}	159.50^{a}
9	180	84.78^{a}	2.18^{a}	16.88^{a}	18.52^{a}	155.50^{a}
SE		1.02	0.27	0.59	1.54	3.62
Sex						
Male	270	87.23^{a}	2.19^{a}	17.87^{a}	19.77^{a}	161.25^{a}
Female	270	84.96^{a}	2.39^{a}	16.83^{a}	20.15^{a}	156.33^{a}
SE	0.83	0.22	0.48	1.26	2.95	

^{a,b,c}: Means in the same column not sharing common superscript are significantly. different (P<0.05). SE: Standard error

breast weights as those on 7 days of feed restriction. Broiler chickens on 9 days of feed restriction had live weights and breast meat weights similar (P>0.05) to those on 7 days of feed restriction.

Results of the effects of sex, level and period of feed restriction at the starter stage had no effect (P>0.05) on nitrogen content of breast meat samples of Ross 308 broiler chickens at 42 days of age as shown in Table 8.

Discussion

Quantitative feed restriction during the starter period affected live weight of the broiler chickens at 21 days of age. The more severe the feed restriction the lower was the live weight attained at 21 days of age. This could be explained in terms of lower feed intake and hence, lower nutrient intake. The lower feed intake was attributed to smaller amounts of feed offered. These findings are in line with previous studies by Leu *et al.* (2002), Oyedeji and Atteh (2005) and Rezaei *et al.* (2006) which reported that feed restriction during the starter period had an effect on live weight of the broiler chickens at the commencement of the realimentation period. However, the present results are different from those of Plavnik and Hurwitz (1989) and Giachetto *et al.* (2003) who observed no differences when chickens were subjected to feed restriction. In the present study, the feed-restricted birds had better feed conversion ratio as compared to their *ad-libitum* counterparts. This is similar to the findings of Plavnik and Hurwitz (1988b) and Oyediji *et al.* (2003); Oyediji and Atteh, 2005). Even though quantitative feed restriction, in the present experiment, had effects on live weight, fat pad and intestine lengths of the broiler chickens at 21 days of age, it did not have any effects on dressing percentage and the weights of gizzard and liver. Saleh *et al.* (2004) reported that the cause of similar dressing percentage of the broiler chickens was due to a constant energy to protein ratio over the experimental period. This was the case in the present study where the ratio of energy to protein was maintained at a constant level for all treatments. Period of feed restriction during the starter phase affected live weight of the chickens. Broiler chickens having more days of feed restriction tended to have lower live weights at 21 days of age. This could be explained in terms of lower feed intake over more days. These findings are similar to those of Arce *et al.* (1992). Male and female broiler chickens had similar live weights at the end of feed restriction. Even though male chickens had better feed intake, female chickens had better feed conversion ratio. In the present study, broiler chickens on 75% *ad-libitum* feeding attained complete live weight compensation at the age of 42 days. This could be explained in terms of high intake expressed as a percentage of live weight. However, it could not be explained in terms of better feed conversion ratio, digestibility, nitrogen retention or metabolisable energy of the broiler chickens during the realimentation period. In fact, birds on *ad-libitum* feeding had better feed conversion ratio. These results are similar to those of Zubair and Leeson (1994a, 1996). However, the present results are contrary to the findings of Fanguy *et al.* (1980). Broiler chickens on 50% *ad-libitum* feeding did not 'catch-up' with those on *ad-libitum* feeding in terms of live weight. This could be explained in terms of similarities in feed intake, growth rate, feed conversion ratio and intestinal length between birds on 50% *ad-libitum* feeding and those on *ad-libitum* feeding. However, these results could not be explained in terms of feed intake as a percentage of live weight. In fact, broiler chickens on 50% *ad-libitum* feeding had higher feed intake expressed as a percentage of live weight. The present results are similar to those of Yu *et al.*, (1990), Mazzuco *et al.* (1999), Sartori *et al.* (1999) and Mazzuco *et al.* (2000) who reported no significant growth

Table 5: Effect of sex, level and period of feed restriction on feed intake (g DM/bird/day), growth rate (g/bird/day), intake as percentage of live weight, feed conversion ratio (FCR) (g feed /g live weight gain) and mortality (%) Ross 308 broiler chickens between 22 and 42 days of age

	Variable					
Treatment	No	Feed intake (g)	Intake as % of lwt	Growth rate (g)	FCR (g feed /g lwtg)	Mortality (%)
Restriction						
0 % *ad-libitum*	180	152.52^{a}	7.48^{b}	65.59^{a}	2.33^{b}	2.78^{a}
75 % *ad-libitum*	180	155.67^{a}	7.48^{b}	62.62^{a}	2.51^{a}	2.78^{a}
50 % *ad-libitum*	180	150.60^{a}	8.17^{a}	64.32^{a}	2.36^{b}	1.39^{a}
SE		1.99	0.16	1.22	0.05	1.19
Period						
5	180	153.20^{a}	7.65^{a}	65.26^{a}	2.36^{a}	1.39^{a}
7	180	155.32^{a}	7.95^{a}	63.56^{a}	2.47^{a}	2.78^{a}
9	180	150.25^{a}	7.99^{a}	63.71^{a}	2.37^{a}	2.78^{a}
SE		1.99	0.16	1.22	0.05	1.19
Sex						
Male	270	157.40^{a}	7.60^{b}	67.84^{a}	2.33^{b}	1.85^{a}
Female	270	148.46^{b}	8.13^{a}	60.51^{b}	2.47^{a}	2.78^{a}
SE	1.62	0.13	0.99	0.04	0.97	

^{a,b,c}: Means in the same column not sharing common superscript are significantly. different (P<0.05). SE: Standard error. Lwtg: Live weight gain.

Table 6: Effect of sex, level and period of feed restriction on dry matter digestibility, nitrogen digestibility (decimal), nitrogen retention (g/bird/day) and metabolisable energy (MJ/kg DM) of Ross 308 broiler chickens between 40 and 42 days of age

	Variable				
Treatment	No	DM Digestibility	Nitrogen Digestibility	Nitrogen retention	Metabolizable energy
Restriction					
0 % *ad-libitum*	180	0.74^{a}	0.62^{b}	1.73^{b}	11.56^{b}
75 % *ad-libitum*	180	0.77^{a}	0.71^{a}	2.19^{a}	12.15^{a}
50 % *ad-libitum*	180	0.76^{a}	0.69^{a}	2.12^{a}	12.08^{ab}
SE		0.01	0.03	0.13	0.18
Period					
5	180	0.75^{a}	0.68^{a}	2.02^{a}	11.96^{a}
7	180	0.74^{a}	0.65^{a}	1.95^{a}	11.74^{a}
9	180	0.77^{a}	0.68^{a}	2.08^{a}	12.10^{a}
SE		0.01	0.03	0.13	0.18
Sex					
Male	270	0.75^{a}	0.67^{a}	1.99^{a}	11.77^{a}
Female	270	0.76^{a}	0.67a	2.04^{a}	12.09^{a}
SE		0.01	0.02	0.10	0.15

^{a,b,c}: Means in the same column not sharing common superscript are significantly. different (P<0.05). SE: Standard error

'catch-up' by the age of 42 days following feed restriction during the starter stage. Similarly, other authors (Leeson *et al.,* 1991; Ballay *et al.,* 1992; Santoso *et al.,* 1993; Deaton, 1995; Giachetto *et al.,* 2003) have reported no effects on live weight and carcass characteristics at the age of 42 days following feed restriction during the starter stage. However, the results of the present study are contrary to those of Gonzales *et al.* (1998) who found complete compensation in live weight of broiler chickens subjected to feed restriction during the starter stage.

The differences in live weight due to the period of feed restriction during the starter stage were maintained up to the age of 42 days. This means that there was no compensation in live weight during the realimentation period. This could be explained in terms of similar feed intake, growth rate, feed conversion ratio, dry matter and nitrogen digestibilities, nitrogen retention, metabolisable energy and intestine length. Other studies have also shown that the longer the period of undernutrition, the more difficult it is for broiler chickens to compensate for reduction in live weight (Yu and Robinson, 1992). Feed restriction for a period of one week starting from seven days of age allowed complete body weight recovery (Plavnik and Hurwtz, 1988 a and b). However, recovery was not seen when restriction was imposed immediately after hatching (Fanguy *et al.,* 1980). Male broiler chickens had higher live weights, thigh, drumstick, wing, gizzards and liver weights at 42 days of age. However, sex had no effect on fat pad weight. The better performance of male chickens in the present study could be explained in terms of higher feed intake and growth rate, a better feed conversion ratio and longer intestines. However, these findings could not be attributed to dry matter and nitrogen digestibilities,

Table 7: Effect of sex, level and period of feed restriction on parts when expressed as percentage of carcass weight of Ross 308 broiler chickens at 42 days of age

	Variable						
Treatment	No	Breast	Thigh	Drumstick	Wing	Gizzard	Liver
Restriction							
0 % *ad-libitum*	180	30.02[a]	7.84[a]	6.73[a]	5.75[a]	2.56[a]	3.23[a]
75 % *ad-libitum*	180	30.01[a]	7.53[a]	7.02[a]	5.89[a]	2.69[a]	3.35[a]
50 % *ad-libitum*	180	31.03[a]	7.80[a]	6.99[a]	5.83[a]	2.65[a]	3.46[a]
SE		0.59	0.11	0.16	0.12	0.09	0.09
Period							
5	180	30.51[a]	7.78[a]	6.85[a]	5.74[a]	2.66[a]	3.26[a]
7	180	30.53[a]	7.74[a]	6.97[a]	5.86[a]	2.59[a]	3.35[a]
9	180	30.02[a]	7.65[a]	6.92[a]	5.86[a]	2.64[a]	3.43[a]
SE		0.59	0.11	0.16	0.12	0.09	0.09
Sex							
Male	270	30.01[a]	7.67[a]	7.03[a]	5.72[a]	2.63[a]	3.32[a]
Female	270	30.70[a]	7.78[a]	6.79[a]	5.92[a]	2.63[a]	3.38[a]
SE		0.49	0.09	0.13	0.09	0.07	0.07

[a,b,c]: Means in the same column not sharing common superscript are significantly. different (P<0.05). SE: Standard error

Table 8: Effect of sex, level and period of feed restriction on nitrogen content (g/kg DM) of breast meat samples of Ross 308 broiler chickens at 42 days of age

Treatment	No	Nitrogen
Restriction		
0 % *ad-libitum*	180	140.95[a]
75 % *ad-libitum*	180	141.42[a]
50 % *ad-libitum*	180	140.29[a]
SE		0.79
Period		
5	180	140.86[a]
7	180	140.73[a]
9	180	141.03[a]
SE		0.79
Sex		
Male	270	140.38[a]
Female	270	141.37[a]
SE		0.65

[a,b,c]: Means in the same column not sharing common superscript are significantly. different (P<0.05). SE: Standard error.

nitrogen retention or metabolisable energy during the realimentation period. The abdominal fat pad weight was not affected by level and period of feed restriction and sex of the chickens. There is inconsistent information on fat deposition in broiler chickens following feed restriction. The present work is in agreement with the findings of Summers *et al.* (1990), Yu *et al.* (1990), Santoso *et al.* (1993), Fontana *et al.* (1993), Sheiddeler and Bauzhman (1993), Deaton (1995) and Ramlah *et al.* (1996), but are in contrast to reports by Plavnik and Hurwitz (1985, 1988a, 1991), Palo *et al.* (1995), Jones and Farrell (1992) and Santoso *et al.* (1995). Zubair and Leeson (1996) also reported that feed restricted birds had the same percentae of fat content as the control birds, suggesting that it is mainly due to the hypertrophy of the fat cells rather than hyperplasia. Rosebrough and McMurtry (1993) suggested that under-nutrition and re-feeding regimen produce an increase in total body fat. The activities of the enzymes associated with hepatic lipogenesis are depressed during the nutrient restriction periods, but after re-feeding their activity is increased (Rosebrough *et al.,* 1986; McMurtry *et al.,* 1988). The fact that there was no significant reduction in fat pad in the present work suggests that even feed-restricted broiler chickens were still eating and that the level of feed intake may control de novo lipogenesis (Rosebrough and McMurtry, 1993). At slaughter age of 42 days, the level and period of feed restriction did not have an effect on gizzard, liver and intestine length of the previously restricted re-fed broiler chickens. This could be possible as pointed out by Zubair and Leeson (1994b) that another adaptation exhibited by the restricted-refed broiler chickens is the relative enlargement of digestive organs, especially the gizzard, crop, pancreas and liver which enhance feed intake and help support compensatory growth or could be due to the theory of repartitioning nutrients by the birds in favour of the supply organs when restricted (Govaerts *et al.,* 2000). Palo *et al.* (1995) suggested that the supply organs of previously restricted broiler chickens need to catch-up first when realimented and eventually exceed in absolute weight of the *ad-libitum* birds before compensatory growth can occur.

Conclusions: Level of feed restriction at the starter stage affected productivity, abdominal fat pad and intestinal length while period of restriction had no effect on any of the carcass traits of both male and female broiler chickens at 21 days of age. Broiler chickens on 75% *ad-libitum* feeding were able to attain complete live weight compensation by 42 days of age. This ‘catch-up’ could only be explained in terms of higher intake expressed as a percentage of live weight. However, chickens on 50% ad- libitum feeding did not ‘catch-up’ with those on *ad-libitum* feeding in terms of live weight. This could not be attributed to any of the factors studied.

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