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Effect of Different Feed Restriction Regimes During the Starter Stage on Productivity and Carcass Characteristics of Male and Female Ross 308 Broiler Chickens

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Abstract: An experiment was conducted to determine the effect of different feed restriction regimes during the starter stage (14-21 days) on productivity and carcass characteristics of male and female Ross 308 chickens. A 3 (feeding levels: *ad-libitum intake*, 50% *ad-libitum* intake and 75% *ad-libitum* intake) × 2 (male and female chickens) factorial arrangement in a complete randomized design was used. Feed restriction affected ($p<0.05$) live weight of chickens at the age of 21 days and male chickens were heavier ($p<0.05$) than females at the same age. Chickens on 75% *ad libitum* feeding attained complete compensation in live weight at 42 days of age while those on 50% *ad libitum* feeding did not. However, male chickens attained higher ($p<0.05$) live weights than female chickens at 42 days of age. It is suggested that 75% *ad libitum* restriction feeding during the starter stage from 14 up to 21 days of age may offer some economic advantage over *ad-libitum* feeding regimen, mainly by enhancing feed utilization. It may, therefore, be a useful nutritional strategy to reduce the cost of commercial starter grain based-diets.

Key words: Ross 308 broiler chickens, starter stage feed restriction, productivity, carcass characteristics, fat deposition

INTRODUCTION

The development of alternative fuels including bio ethanol produced from maize and bio diesel from plant oils is likely to result in an increased cost of feed stuff for broiler nutrition since there is expectation that world cereal availability for livestock especially poultry will be highly restricted. Therefore, there is a critical need to increase efforts of reducing feed cost without compromising the final productivity. One possible nutritional strategy of reducing feed cost is to restrict feed intake of the birds in the early stage of life.

Although some studies have determined the effect of early feed restriction on carcass fat contents and feed efficiency (Plavnik and Hurwitz, 1988, 1991), leg problems and total mortality (Robinson *et al*., 1992; Saleh *et al*., 1996) and metabolic diseases (Arce *et al*., 1992) in broiler chickens, there is little or limited information concerning the use of early feed restriction as a nutritional approach to reduce cost of poultry feed. It is, therefore, important to ascertain such responses in broiler chickens subjected to different feed restriction regimes during the starter stage. Such information would be very beneficial to poultry farmers in rural areas of Limpopo province and elsewhere. The main objective of this study was to determine the effect of different feed restriction regimes during the starter stage on productivity and carcass characteristics of male and female Ross 308 broiler chickens.

MATERIALS AND METHODS

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

Birds, treatment, design and data collection: Male and female Ross 308 broiler chickens were raised for 14 days before the commencement of the study. On commencement, 300 male and female Ross 308 broiler chickens were randomly allocated to 6 treatment combinations (Table 1) with five replications in a 3 (feeding regimes: *ad-libitum* feeding as the control, 75% *ad-libitum* intake and 50% ad-*libitum* intake of amount of feed intake of *ad-libitum* chickens of the previous day, respectively) X2 (sexes of chickens) factorial arrangement in a complete randomized design (SAS, 2000). There were 30 floor pens, each containing 10 birds per replication. Realimentation period was from day 22 until day 42. Except for the duration of the food restriction, the birds were offered feed and fresh water *fed ad-libitum*. The lighting program was 24 h. The experiment was terminated when birds were 42 days of age. During the experiment, the initial average live weights of the chickens were taken at 14 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 experimental period. At day 36, four birds were randomly

Table 1: Experimental treatments

Treatments	
SMR_0:	Male chickens without any starter feed restriction
SMR_{75} :	Male chickens fed 75% of the control intake for seven days
SMR_{50} :	Male chickens fed 50% of the control intake for seven days
SFR_0:	Female chickens without any starter feed restriction
SFR_{75}:	Female chickens fed 75% of the control intake for seven days
SFR_{50}:	Female chickens fed 50% of the control intake for seven days

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 (2002). 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 2002).

Data analysis: Effect of different feed restriction regimes during the starter stage on productivity and carcass characteristics of male and female Ross 308 broiler chickens on live weight, feed intake, feed conversion ratio, digestibility, carcass characteristics and mortality were analyzed using the General Linear Model (GLM) procedures of statistical analysis of variance (SAS 2000). Means were separated using Duncan (1955) multiple-range test. 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. Prior to this experiment, the chicks were fed a 23% CP starter diet that would satisfy their nutritional requirements according to the NRC (1994).

Results of the effects of level of feed restriction on live weight, feed intake and mortality of male and female Ross 308 broiler chickens at 21 days of age are presented in Table 3 Level of feed restriction had effects ($p<0.05$) on live weight and feed intake of broiler chickens. Increasing the level of feed restriction reduced ($p<0.05$) live weights and feed intakes of broiler chickens. However, level of feed restriction did not have any effect ($p>0.05$) on mortality of chickens during the restriction period. Male and female broiler chickens had similar ($p>0.05$) feed intakes and mortality rates. However, male broiler chickens were heavier ($p<0.05$) than female chickens at 21 days of age. Results of the effects of level of feed restriction on feed intake, intake as percentage of live weight, growth rate, feed conversion ratio and mortality of male and female Ross 308 broiler chickens between 21 and 42 days of age are presented in Table 4. Level of feed restriction had no effect ($p>0.05$) on feed intake, growth rate, feed conversion ratio and mortality of the broiler chickens. Sex of the chickens had no effect ($p>0.05$) on mortality. However, male broiler chickens had higher ($p<0.05$) feed intake and growth rate and better feed conversion ratio than female broiler chickens. When intake was expressed as percentage of live weight, differences ($p<0.05$) in feed intake were observed between chickens on 75 and 50% *ad libitum* feeding and those on *ad libitum* feeding. When intake was expressed as percentage of live weight, male chickens had lower ($p<0.05$) feed intake than female chickens. Results of the effects of level of feed restriction and sex of the chickens on diet dry matter and nitrogen digestibilities, nitrogen retention and metabolisable energy are presented in Table 5. Feed restriction levels and sex of the broiler chickens had no effect ($p>0.05$) on dry matter digestibility, nitrogen digestibility and nitrogen retention. However, chickens on 75% *ad libitum* feeding had lower ($p<0.05$) metabolisable energy values than those on *ad libitum* feeding and those on 50% *ad libitum* feeding. Broiler chickens on 50% *ad libitum* feeding and those on *ad libitum* feeding had similar ($p>0.05$) metabolisable energy values. Results of the effects of feed restriction on live weight, dressing percentage and carcass characteristics of male and female Ross 308 broiler chickens at 42 days of age are presented in Table 6. Level of feed restriction had no effect ($p>0.05$) on dressing percentage and intestine lengths, as well as on weights of wing, fat pad, gizzard and liver. However, chickens on 50% *ad libitum* feeding had lower ($p<0.05$) live weights, drumstick and breast weights than those on *ad libitum* feeding. Male and female broiler chickens had similar ($p>0.05$) dressing percentages and fat pad weights. However, male broiler chickens had higher ($p<0.05$) intestine lengths, live weights and thigh, drumstick, wing, breast and liver weights than female chickens. Level of feed restriction and sex of the chickens had no effect ($p>0.05$) on breast, thigh, drumstick, wing, gizzard and liver weights when expressed as percentage of carcass weight of the chickens at 42 days of age (Table 7). Level of feed restriction and sex of the chickens had no effect ($p>0.05$) on nitrogen content of breast meat samples of Ross 308 broiler chickens at 42 days of age (Table 8).

DISCUSSION

Feed restriction during the starter period affected live weight of the broiler chickens at the age of 21 days. The more severe the feed restriction the lower was the live weight attained at 21 days of age in both male and

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)

Diet	Dry matter	Energy	Nutrient protein	Lysine	Fat	Calcium	Phosphorus
Starter	880	16.0	230	11.0	25	12	6.0
Grower	880	15.5	199	11.5	25	10	5.5

Table 3: Effect of level of feed restriction on feed intake (g/bird/day), live weight (g/bird) and mortality (%) of male and female Ross 308 broiler chickens at 21 days of age

		Variable		
Treatment	No	Live weight	Feed Intake	Mortality
Restriction				
0% *ad libitum*	100	494[a]	86[a]	0.0[a]
75% *ad libitum*	100	430[b]	64[b]	0.0[a]
50% *ad libitum*	100	348[c]	43[c]	0.5[a]
SE		5.65	1.44	0.32
Sex				
Male	150	432[a]	65[a]	0.4[a]
Female	150	415[b]	64[a]	0.0[a]
SE		4.61	1.18	0.26

[ab,c]:Means in the same column not sharing a common superscript are significantly different ($p<0.05$). SE: Standard Error

female broiler chickens. This was expected since live weight gain depends on nutrient intake. Thus, those chickens offered lower amounts of feed attained lower live weights. These results are similar to the findings of Leu *et al.* (2002) and Oyedeji and Atteh (2005). The level of feed restriction which Plavnik and Hurwitz (1989) estimated just to meet maintenance energy requirements is equivalent to about 167 KJ ME/bird/day in the 6-12 day period, approximately 35% of normal feed intake. This maintenance energy level, however, must have been overestimated because the feed-restricted birds gained 2-4 g body weight each day during the restricted period. It is also possible, as suggested by some workers, that the birds in their study, even though in negative energy balance, were able to gain weight due to change in body composition: they used fat reserves and deposited more lean tissues (Leeson *et al.*, 1991; Yu and Robinson, 1992). In the present study, level of feed restriction had no effect on mortality of the chickens. This is similar to results reported by Oyedeji and Atteh (2005). However, the present results are contrary to the findings of Saleh *et al.* (2005) who reported that level of feed restriction had effects on mortality of the broiler chickens.

Male broiler chickens were heavier than female chickens at the end of feed restriction period. However, there were no significant differences in intake and mortality. Thus, differences in live weight could not be explained in terms of differences in feed intake. It is possible that differences in live weight may have been due to better feed conversion ratio in male chickens compared to female chickens. These results are similar to those of Zubair and Leeson (1994). However, the present results are contrary to those reported by Leeson *et al.* (1991). The present results indicate that at 42 days of age broiler chickens on 75% *ad libitum* feeding attained similar live weights to those on *ad libitum* feeding. This means that there was complete compensation. This could only be explained in terms of higher intake expressed as percentage of live weight for those chickens on 75% *ad libitum* feeding. However, broiler chickens on 50% *ad libitum* feeding had lower live weights, drumstick and breast meat weights than those on *ad libitum* feeding. These results indicate that complete compensation did not occur in broiler chickens on 50% *ad libitum* feeding. Plavnik and Hurwitz (1991) carried out a trial in which they offered broiler chicks or turkey poults varying levels of energy-restricted diets to determine the effect of compensatory growth on the fat content of the abdominal fat pad. While the turkey poults were able to fully compensate from all levels of restriction, the broiler chickens were only able to fully compensate from the mildest restrictions. Similarly, other workers were unable to demonstrate complete compensatory growth of broiler chickens which had been subjected to similar degrees of feed restriction (Pinchasov *et al.*, 1985; Plavnik *et al.*, 1986; Calvert *et al.*, 1987; Pinchasov and Jensen, 1989; Yu *et al.*, 1990). Leeson *et al.* (1991), reported complete body weight recovery by all treatment groups by 42 days of age with no change in overall efficiency. Carcass characteristics were also not affected by early life undernutrition. Jones and Farrell (1992) restricted broiler chickens to only 2.9 $KJ/kg^{0.67}$, a level much more severe than that recommended by Plavnik and Hurwitz (1989) and reported complete body weight recovery at 48 days of age. Plavnik and Hurwitz (1991) showed that milder feed restriction, which allowed 60-70% of normal growth, permits more realistic recovery.

Male broiler chickens attained higher live weights than female chickens at 42 days of age. This is similar to the findings of Plavnik and Hurwitz (1991). However, the present results are in contrast to the results of Lippens *et al.* (2000). The higher live weights observed in male chickens in the present study could be explained in terms of higher intake, growth rate and better feed conversion ratio. Additionally, male chickens had longer intestines. However, the present results could not be explained in terms of higher dry matter and nitrogen digestibilities, intake as a percentage of live weight,nitrogen retention or metabolizable energy during realimentation period. In fact, female chickens had higher intake values when intake was expressed as a percentage of live weight. These results are similar to those of Leu *et al.* (2002).

Table 4: Effect of level of feed restriction on feed intake (g/bird/day), intake as percentage of live weight, growth rate (g/bird/day), feed conversion ratio (FCR) (g feed/g live weight gain) and mortality (%) of male and female Ross 308 broiler chickens between 21 and 42 days of age

		Variable				
Treatment	No	Feed intake	Intake as % of live weight	Growth rate	FCR	Mortality
Restriction						
0% *ad-libitum*	100	103[a]	6[b]	46[a]	2.2[a]	2.0[a]
75% *ad-libitum*	100	105[a]	7[a]	45[a]	2.3[a]	0.6[a]
50% *ad- libitum*	100	103[a]	7[a]	45[a]	2.2[a]	2.0[a]
SE		1.22	0.15	0.98	0.04	1.45
Sex						
Male	150	106[a]	7[b]	47[a]	2.2[a]	1.8[a]
Female	150	101[b]	8[a]	44[b]	2.3[b]	1.3[a]
SE		1.00	0.12	0.80	0.03	1.1

[ab,c]:Means in the same column not sharing a common superscript are significantly different ($p<0.05$). SE: Standard Error

Table 5: Effect of level of feed restriction on diet dry matter and nitrogen digestibilities (decimal), nitrogen retention (g/bird/day) and metabolisable energy (MJ/kg DM) of male and female Ross 308 broiler chickens between 36 and 42 days of age

		Variable			
Treatment	No	Dry matter digestibility	Nitrogen digestibility	Nitrogen retention	Metabolisable energy
Restriction					
0% *ad-libitum*	100	0.84[a]	0.74[a]	1.88[a]	13.17[ab]
75% *ad-libitum*	100	0.83[a]	0.75[a]	1.91[a]	13.02[b]
50% *ad- libitum*	100	0.84[a]	0.76[a]	1.99[a]	13.32[a]
SE		0.01	0.01	0.06	0.08
Sex					
Male	150	0.85[a]	0.74[a]	1.90[a]	13.09[a]
Female	150	0.85[a]	0.76[a]	1.96[a]	13.24[a]
SE		0.00	0.00	0.05	0.07

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

Table 6: Effect of level of feed restriction on performance, carcass characteristics and dressing percentage of male and female Ross 308 broiler chickens at 42 days of age

		Variables									
Treatment	No	Live Weight	Dressing %age	Thigh (g)	Drum stick (g)	Wing (g)	Breast (g)	Fat (g)	Gizzard (g)	Liver (g)	Intestine length (cm)
Restriction											
0% *adlib.*	100	1493[a]	86[a]	82.43[a]	72.20[a]	64.38[a]	273.92[a]	12.41[a]	34.10[a]	37.87[a]	243.89[a]
75% *adlib.*	100	1426[ab]	85[a]	78.14[ab]	70.37[a]	63.91[a]	261.96[ab]	9.75[a]	35.23[a]	37.15[a]	229.83[a]
50% *adlib.*	100	1361[b]	88[a]	75.33[a]	64.28[b]	60.15[a]	246.19[b]	10.24[a]	34.68[a]	36.97[a]	236.06[a]
SE		28.71	1.64	2.25	2.11	1.42	6.17	1.50	1.33	1.12	7.96
Sex											
Male	150	1506[a]	85[a]	82.79[a]	73.11[a]	65.18[a]	268.50[a]	9.16[a]	37.37[a]	39.61[a]	226.61[a]
Female	150	1348[b]	87[a]	74.47[b]	64.79[b]	60.44[b]	252.88[b]	12.44[a]	31.97[b]	35.05[b]	208.55[b]
SE		23.44	1.34	1.84	1.73	1.59	5.04	1.22	1.08	0.91	3.78

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

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

		Variable					
	No	Thigh	Drumstick	Wing	Breast	Gizzard	Liver treatment
Restriction							
0% *ad libitum*	100	6.45[a]	5.65[a]	5.05[a]	21.50[a]	1.33[a]	1.49[a]
75% *ad libitum*	100	6.52[a]	5.94[a]	5.35[a]	22.06[a]	1.49[a]	1.56[a]
50% *ad libitum*	100	6.28[a]	5.35[a]	5.03[a]	20.59[a]	1.45[a]	1.54[a]
SE		0.16	0.22	0.16	0.62	0.07	0.05
Sex							
Male	150	6.54[a]	5.81[a]	5.18[a]	21.33[a]	1.50[a]	1.58[a]
Female	150	6.29[a]	5.48[a]	5.11[a]	21.49[a]	1.35[a]	1.48[a]
SE		0.13	0.18	0.13	0.50	0.05	0.04

[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 level of feed restriction on nitrogen content (g/kg DM) of male and female Ross 308 broiler chickens breast meat samples at 42 days of age

Treatment	No	Nitrogen
Restriction		
0% *ad libitum*	100	142.04[a]
75% *ad libitum*	100	142.02[a]
50% *ad libitum*	100	142.20[a]
SE		0.53
Sex		
Male	150	141.65[a]
Female	150	142.53[a]
SE		0.43

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

Conclusion: Feed restriction at the starter stage affected the live weight of broiler chickens at 21 days of age. Chickens on 75% *ad libitum* feeding attained complete compensation in live weight while those on 50% *ad libitum* feeding did not. It is suggested that 75% *ad libitum* restriction feeding during the starter stage from 14 up to 21 days of age may offer some economic advantage over *ad-libitum* feeding regimen, mainly by enhancing feed utilization. It may, therefore, be a useful nutritional strategy to reduce the cost of commercial starter grain based-diets.

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