

Effect of Restricted Feeding on the Growth Performance of Koekoek Chickens

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ABSTRACT

The objective of this study was to determine the effect of restricted feeding on growth performance of Koekoek chickens. Two hundred and seventy Koekoek chickens were randomly allocated to four feeding treatments. The four treatments were AA (full feeding throughout the study), AR (full feeding for rearing and feed restriction for laying), RA (feed restriction for rearing and full feeding for laying phase) and RR (restricted feeding throughout the study). Feed restriction during the rearing phase (AA and AR) significantly ($P < 0.05$) increased the final body weights and total weight gains of chickens. The feed intake was significantly higher in full-fed chickens. Unrestricted feeding during the rearing phase (AA and AR) significantly improved the average feed conversion ratio. During the laying phase, final body weights of chickens in RA treatment were significantly heavier compared to those in other treatments. Chickens in RA treatment gained ($P < 0.05$) more weight followed by birds in AA, RR and AR treatments respectively. The chickens that were feed restricted only during the laying phase (RA) were significantly efficient in feed conversion. Therefore, it is concluded that early feed restriction is the best feeding management strategy.

Key words: Full-fed, weight gain, feed intake, feed conversion ratio, mortality rate

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INTRODUCTION

Local farmers in the rural areas of Lesotho are faced with the problem of malnutrition due to the shortage of animal protein. This has been caused by the escalating feed costs hence the majority of poor resource farmers cannot avoid to rear Koekoek chickens. This is posing a threat of serious malnutrition (Ukachukwu and Akpan, 2007). In a way to reduce the increased feeding costs one of the management strategies which could be employed is feed restriction. Restricted feeding has been reported to improve the feed utilization efficiency in chickens (Banalve, 1984). Crouch *et al.* (2002a) reported that quantitative feed restriction reduces the body weight and feed consumption of birds without necessarily affecting the egg production. Chickens that have been restricted fed early in the production and fed *ad libitum* at a later stage resulted in a compensatory growth (Bruggemen *et al.*, 1999). Apart from saving the quantity of feed given to chickens, feed restriction has been reported by several researchers in reducing mortality of chickens (Naraharl *et al.*, 1975; Lippens *et al.*, 2000; Tolcamp *et al.*, 2005; Robert, 2009).

This study was aimed at investigating the effect of feeding level on the growth performance of Koekoek chickens.

MATERIALS AND METHODS

This study was conducted at the experimental farm of the Faculty of Agriculture, National University of Lesotho

(NUL) based in Roma. Roma is 35 km from Maseru. Two hundred and seventy (270) Koekoek hens and twenty seven (27) Koekoek cocks at the age of eight weeks were bought from the Government Poultry National Hatchery in Maseru. The birds were raised on floor pens littered with dry grass. The floor space for each pen was 2.5 m² and each pen accommodated 10 birds. The wall from the floor to the height of 1.5 meters was made up of corrugated iron sheets. The wall height up to the roof was made up of chicken wire mesh and the structure was roofed with corrugated iron sheets. The shelter was allowed for good ventilation. Water was supplied in suspended drinkers *ad libitum*. Koekoek chickens were fed pullet grower diet from the age of 8 to 18 weeks followed by laying mash. All Koekoek chickens were given stress pack dissolved in water on arrival. Chickens that showed any sign of illness or diarrhea were treated accordingly.

Koekoek chickens were divided into four feeding levels denoted as groups AA, AR, RA and RR with each treatment replicated seven times with the exception of birds in RR treatment which were replicated six times making a total of 27 experimental units. Each feeding regime treatment consisted of 70 hens and 7 cocks in AA, AR and RA while the RR treatment had 60 hens and 6 cocks. Ten hens and one cock were kept in a pen. Chickens in AA treatment were full-fed during the rearing and the laying phase. Birds in AR treatment were full-fed during the rearing phase and were shifted to restricted feeding during the laying phase. Chickens in RA feeding

regimen were on restricted feeding in the rearing phase and placed on full feeding during the laying period while in the last group (RR) the birds were subjected to feed restriction during both rearing and laying phases.

The restricted feeding was 70 percent of the total daily feed intake of the bird per day during both growing and laying periods. The feed used was a complete rearing and laying feed bought from the commercial feed manufacturer.

Throughout the experimental period Koekoek chickens were weighed every two weeks by choosing a random sample of 21 birds in AA, AR, RA treatments and 18 birds in RR treatment in order to establish their average weight for age, weight gains, feed intake and feed conversion ratio (FCR). All mortality was recorded. Data was recorded in excel spreadsheet and averages were calculated. Data was tested for normal distribution. ANOVA was used to separate the effects of feeding level and season on body weights, body weight gain, feed intake, feed conversion ratio and mortality. If significant, treatment effects were analyzed and differences between treatments were tested by Duncan's new multiple-range test (Duncan, 1955). The General Linear Models Procedure, SPSS (17.00) was used. Threshold for significance was $P < 0.05$.

RESULTS AND DISCUSSION

The results of the growth performance of Koekoek chickens are presented in Table 2. The results are for rearing and laying phases. Birds that were full-fed (AA and AR) had higher ($P < 0.05$) body weights than restricted fed groups (RA and RR). A critical analysis of the results from the 10th to the 18th week indicates that the difference between the mean weights of birds that were full-fed and the restricted fed group increases as the birds' age. This can be proved by the fact that the mean difference between birds that were subjected to restricted feeding and full feeding increased by 22.16% from the age of 10 weeks to 18 weeks. Birds that were full-fed (AA and AR) had an average weight of 1.58 kg at 18 weeks as compared to birds that were feed restricted with an average weight of 1.19 kg at the age of 18 weeks. Growth of full-fed birds differed ($P < 0.05$) from restricted fed birds. The results obtained from this research project are in agreement with the results of Tesfaye *et al.* (2009) who indicated that the growth of hens is reduced by feed restriction. Mahmood *et al.* (2007) also said that feed restriction reduced adult body weight of chickens by 20% compared with full-fed chickens. Mahmood *et al.* (2007) and Tasfaye *et al.* (2009) also reported a reduced weight gain in feed restricted birds. The explanation of the lower body weight in feed restricted birds could probably be attached to the lower amount of feed intake compared to full-fed birds.

In the laying phase, birds in AA and RA treatments were full-fed while birds in AR and RR treatments were under restricted feeding. It can be depicted from this research project that birds that were full-fed during both phases (AA) continued to grow faster ($P < 0.05$) than birds in all other treatments (AR, RA and RR) up until birds reached 24 weeks of age. These results are in agreement with Hassan *et al.* (2003) who indicated that the body

Table 1: Nutrient composition of grower mash and layer mash that was fed Koekoek chickens

Nutrient	Grower mash (g/kg)	Layer mash(g/kg)
Crude protein	150.0	130.0
Moisture	120.0	120.0
Fibre (maximum)	65	70.0
Calcium (minimum)	27	27.0
Calcium (Maximum)	45.0	45.0
Phosphorus (minimum)	5.0	5.0
Lysine (minimum)	5.0	5.0

Table 2: Effects of restricted feeding on weight (g) for age of Koekoek chickens

Age (wks)	Treatment				S.E
	AA	AR	RA	RR	
Rearing phase (10 - 18 weeks) (Weights, g)					
10	774.60 ^a	775.10 ^a	729.70 ^b	735.70 ^b	1.36
11	888.80 ^a	891.70 ^a	809.40 ^b	808.10 ^b	3.47
12	1005.00 ^a	1004.00 ^a	829.70 ^b	900.90 ^b	2.68
13	1137.00 ^a	1140.00 ^a	957.60 ^b	970.90 ^b	2.80
14	1182.00 ^a	1168.00 ^a	991.30 ^b	996.30 ^b	2.62
15	1329.00 ^a	1320.00 ^a	1109.00 ^b	1098.00 ^b	5.95
16	1399.00 ^a	1395.00 ^a	1090.00 ^b	1099.00 ^b	3.40
17	1506.00 ^a	1503.00 ^a	1209.00 ^b	1206.00 ^b	7.33
18	1575.00 ^a	1582.00 ^a	1187.00 ^b	1195.00 ^b	3.95
Laying phase (19 - 32 weeks) (Weights, g)					
19	1690.00 ^a	1648.00 ^b	1435.00 ^b	1389.00 ^b	5.10
20	1786.00 ^a	1690.00 ^b	1522.00 ^c	1394.00 ^d	4.39
21	1831.00 ^a	1638.00 ^b	1693.00 ^c	1539.00 ^d	5.14
22	1933.00 ^a	1751.00 ^b	1768.00 ^c	1544.00 ^d	4.73
23	2020.00 ^a	1667.00 ^b	1950.00 ^c	1677.00 ^d	5.47
24	2095.00 ^a	1818.00 ^b	2033.00 ^c	1678.00 ^d	4.69
25	2185.00 ^a	1735.00 ^b	2153.00 ^a	1801.00 ^b	5.96
26	2243.00 ^a	1867.00 ^b	2253.00 ^a	1780.00 ^b	4.76
27	2227.00 ^a	1814.00 ^b	2235.00 ^a	1871.00 ^b	6.40
28	2323.00 ^a	1852.00 ^b	2426.00 ^a	1853.00 ^b	4.75
29	2212.00 ^a	1808.00 ^b	2201.00 ^a	1858.00 ^b	7.29
30	2369.00 ^a	1808.00 ^b	2498.00 ^c	1875.00 ^d	5.21
31	2379.00 ^a	1819.00 ^b	2526.00 ^c	1887.00 ^d	6.04
32	2411.00 ^a	1812.00 ^b	2561.00 ^c	1891.00 ^d	5.00

^{abcd} Means within a row with no common superscript differ significantly ($P < 0.05$); AA-full feeding during rearing and laying, AR-full feeding during rearing and restricted during laying, RA-restricted feeding during rearing and full feeding during laying, RR-restricted during rearing and laying, S.E-standard error.

weight of chickens at first egg is significantly less in restricted fed groups compared to full-fed groups. Koekoek chickens that were transferred from restricted to full feeding in the laying phase (RA) were seen to out grow birds that were under restricted feeding treatments (AR and RR) in the laying phase and this was seen to be effective from the 21st week of age. This means that it took almost 14 days for birds in RA treatment to adjust and respond to unrestricted feeding. Koekoek chickens that were under RA treatment seemed to increasingly accelerate their growth rate from the 21st week up to the end of the experimental trial that was 32 weeks of age. There were no statistically differences ($P > 0.05$) in terms of weekly body weights between Koekoek chickens that were in AA and RA treatments for the period covering from 25 to 29 weeks of age. Due to the compensatory growth exhibited by birds in RA treatment the results of this research project demonstrated that from the 30th week onwards birds in RA treatments were heavier ($P < 0.05$) than birds in AA treatment with weight scores of 2498g,

2526g and 2561g for weeks 30, 31 and 32 respectively. This shows that birds in RA treatment were 133 to 155g heavier than birds that were under AA treatment during the last three weeks of the experimental period.

The results obtained from this study agree with the findings of Fontana *et al.* (1992), Lippens *et al.* (2000), Hassan *et al.* (2003), Mahmood (2007), Khetani *et al.* (2008) and Sogut and Kalpak (2009) who reported that birds under restricted feeding have lower feed intake than birds that are given *ad libitum* feed which will later exhibit an accelerated body weight gain when allowed access to unrestricted feeds. Mahmood *et al.* (2007) also indicated that birds with retarded growth due to poor nutrition could achieve a growth rate higher than normal for chronological age after removal of the feed restriction. The previous findings explained that compensatory growth or catch up growth exhibited by restricted fed birds allows the recovery of body weight at slaughter age and sometimes a higher body weight than that of birds fed *ad libitum* as was the case with this research project. Birds that were restricted for the entire experiment (RR) had an average body weight of 1.39 kg at the age 20 weeks which was lower ($P<0.05$) than the average body weights of Koekoek chickens in other treatments which had 1.79kg, 1.70kg and 1.52kg for birds in AA, AR and RA treatments respectively which were all significantly different from one another. The findings of Banalve (1984) states that laying chickens should be feed restricted in order to reach the target body weight of 1.4 kg at 20 weeks of which it was the case with Koekoek chickens that were subjected to RR treatment since they had an average body weight of 1.39 kg.

When comparing Koekoek chickens that were feed restricted during the laying phase (AR and RR), one would recognize that Koekoek chickens that were shifted from full feeding in the rearing phase to restricted feeding during the laying phase (RA) were significantly ($P<0.05$) heavier than their counter parts being birds in RR treatment from week 19 until birds were roughly 24 weeks of age. At the 25th week of age the results indicated no statistical ($P>0.05$) differences between Koekoek chickens that were in AR and RR treatments. The same trend of the results between these two restricted fed treatments in the laying phase continued until Koekoek chickens reached the age of 29 weeks. The results demonstrated that the growth rate of birds in RR treatment out performed ($P>0.05$) the one for chickens in AR treatment as Koekoek chickens were aging. This can be proved by the fact that from the 30th to 32nd week of age birds in RR treatment increased their body weights by approximately 16g while the average body weight of the ones in AR treatment had a small increase of 4g. This could also be because birds that were feed restricted throughout the experiment (RR) were adapted to the situation as compared to birds that were restricted only in the laying phase (AR).

Results shown in Table 3 depict that Koekoek chickens that were subjected to full feeding (AA and AR) during the rearing phase were having higher body weight gains compared to Koekoek chickens that were feed restricted (RA and RR).

Koekoek chickens that were in AA and AR treatments at 10 weeks of age had the mean body weight

Table 3: Body weight gain (g) of Koekoek chickens subjected to different feeding treatments

Age (wks)	Treatment				S.E
	AA	AR	RA	RR	
Rearing phase (10 - 18 weeks) (Weights, g)					
10	117.10 ^a	117.6 ^a	72.19 ^b	78.21 ^b	1.36
12	230.40 ^a	228.70 ^a	163.0 ^b	165.20 ^b	2.97
14	176.60 ^a	163.90 ^a	98.59 ^b	95.340 ^b	2.35
16	217.30 ^a	227.00 ^a	98.41 ^b	102.30 ^b	2.57
18	176.30 ^a	187.80 ^a	97.17 ^b	96.256 ^b	2.62
8-18	917.80 ^a	924.90 ^a	529.40 ^b	537.40 ^b	3.95
Laying phase (20 - 32 weeks) (Weights, g)					
20	211.10 ^a	107.80 ^b	334.90 ^c	199.40 ^d	3.10
22	146.70 ^a	60.41 ^b	246.30 ^c	149.50 ^d	2.71
24	161.80 ^a	67.00 ^b	264.40 ^c	134.70 ^d	2.22
26	147.90 ^a	49.75 ^b	220.50 ^c	101.80 ^d	3.25
28	80.79 ^a	-14.92 ^b	173.40 ^c	72.288 ^d	2.75
30	45.79 ^a	-44.62 ^b	71.535 ^c	22.12 ^d	1.96
32	42.33 ^a	4.60 ^b	63.00 ^c	16.00 ^d	4.99
19-32	721.71 ^a	164.60 ^b	1126.00 ^c	501.86 ^d	6.54
8-32	1754.00 ^a	1155.00 ^b	1904.00 ^c	1234.00 ^d	4.99

^{abcd} Means within a row with no common superscript differ significantly ($P<0.05$); AA-full feeding during rearing and laying, AR-full feeding during rearing and restricted during laying, RA-restricted feeding during rearing and full feeding during laying, RR-restricted during rearing and laying, S.E-standard error.

gains of 117.10g and 117.60g respectively and this were different ($P<0.05$) from the mean body weight gains of birds that were in RA and RR treatments (72.19g and 78.21g). The similar pattern of the results was noticed throughout the rearing stage of Koekoek chickens. When looking at the cumulative body weight gain of Koekoek chickens for the period covering 10 to 18 weeks as reflected in Table 3, it can be noticed that birds that were full-fed gained significantly more weights than the feed restricted group. The average cumulative weight gain for the full-fed birds was 917.80g and 924.90g for birds in AA and AR treatments respectively while the ones for feed restricted birds was 529.40g and 537.40g for birds in RA and RR treatments respectively. These results suggest that both feeding level groups of Koekoek chickens demonstrated a continuous growth from the 10th week up to the 18th week which is the expected age for first oviposition although Koekoek chickens that were full-fed were gaining weight more rapidly than their counterparts. The results from this study displayed a positive cumulative correlation of $r=0.76$ between the total feed intake and the weight gain during rearing period. This reveals that the more the chickens are consuming the faster they will gain weight. This is confirmed by Sun *et al.* (2006) who pointed out that there is positive correlation between the body weight gain of chickens and the age irrespective of whether they are full-fed or restricted.

The findings of this study are in agreement with the results of Mahmood *et al.* (2007) which reflected that a reduced weight gain in restricted fed birds is the result of a reduced feed intake compared to full-fed birds. The results of Eitan and Soller (2001) also said that the body weight of restricted fed birds was significantly less at first egg compared to those in control. Birds that were under restricted feeding (RA and RR) in this study reached sexual maturity with lower body weight gain than the

ones that were under full feeding and this is in line with Colin *et al.* (1992) who suggested that feed restriction should be practiced on heavy breeds in order to avoid the excessive amount of body fat in pullets at sexual maturity and that feed restriction would result in targeted body size before birds start to lay.

During the laying phase the results in Table 3 revealed that Koekoek chickens that were subjected to early feed restriction and shifted to unrestricted feeding in the laying phase (RA) gained more weight (334.90g) than the rest of birds in other treatments (AA, AR and RR) at the 20th week being two weeks after they had been introduced to full feeding. During the same week Koekoek chickens that were full-fed earlier and transferred to restricted feeding in the laying phase (AR) gained the least body weight (107.80g) compared to birds that were full-fed (AA) and restricted fed for the entire study period (RR) which gained 211.10g and 199.40g respectively. Koekoek chickens in RA treatment performed better ($P<0.05$) than chickens in AA, RA and RR treatments from week 20 up to the 32nd week. The results of this study show that chickens in AA, RA and RR treatments gained weight throughout the trial period as against chickens in AR treatment which lost body weight effectively from the age of 28 weeks up to the 30th week of the experiment. The body weight gain seemed to decline with the aging of Koekoek chickens from week 20 up to week 32 although the decline was less noticed in RA treatment Koekoek chickens. This can be verified by the fact that at week 22 the weight gains were 146.70g, 60.41g, 246.30g and 149.50g for birds in AA, AR, RA and RR treatments respectively in a space of two weeks, and 12 weeks later the body weight gains for Koekoek chickens in treatments AA, AR, RA and RR were 42.33g, 4.60g, 63.00g and 16.00g respectively. When considering cumulative body weight gain between the four treatments it can be noticed that Koekoek chickens in RA treatment gained more weight (1126.00g) while the lowest weight gain (164.60g) was in chickens that were subjected to AR treatment ($P<0.05$). Birds in AA and RR treatments had the intermediates weight gains of 721.71g and 501.86g respectively. The results of this study showed the similar pattern even on the grand commutative weight gains (8 to 32 weeks) with birds in AA, AR, RA and RR treatments having the total body weight gains of 1.744kg, 1.146kg, 1.914kg and 1.243kg respectively. A positive correlation ($r=0.59$) was experienced between the total feed intake and the grand body weight gain of chickens.

Eitan and Soller (2001) indicated a gain in body weight of chickens that were feed restricted earlier and later shifted to full feeding. This is in line with the findings of this study which revealed that Koekoek chickens that were in RA treatment had better mean body weight gains. This can further be argued in terms of compensatory growth principle. Birds in AR treatment lost body weight from the age of 28 weeks and this could be because the limited feeds they were getting were not satisfying the growing demands of Koekoek chickens since it is assumed that chickens would require more feeds as they age. Tolcamp *et al.* (2005) indicated that restricted fed birds normally loose weight during the peak laying period because the nutrients intake of birds fails to

meet their metabolic requirement which is believed to be the case in this study.

Table 4 illustrates feed intake of Koekoek chickens that were subjected to different levels of feeding treatments during the rearing and laying phases. Koekoek chickens that were not limited on feeding (AA and AR) had increased ($P<0.05$) feed intake compared to those that were feed restricted (RA and RR) for the entire rearing period (10 to 18 weeks). Koekoek chickens that were fed restrictedly were finishing their feed which was 70% of the feeds that was granted to the ones that were full-fed. At the beginning of the trial, the average feed intake for unrestricted fed Koekoek chickens (AA and AR) was 54.3g and the feed intake for restricted fed chickens was approximately 42.42g on average. It was discovered that Koekoek chickens that were full-fed were able to consume 83g in a day per chicken of pullet grower meal at 18 weeks of age while the restricted fed chickens were eating 58g per day per bird during the same week. The results obtained in this research project are in line with Ukachukwu and Akapan (2007) who reported that feed restriction in pullets depressed feed intake.

The average feed consumption of a Koekoek chicken from 8 to 18 weeks was 70.7g per day for chickens that were in the full feeding treatments (AA and AR) while the average daily feed intake for restricted fed chickens amounted to 51.29g. A total of 4.9 kg per bird was used in full-fed chickens for 10 weeks of rearing period which was higher ($P<0.05$) than the total feed consumption of restricted fed Koekoek chickens (3.6 kg). The findings of the current study are in agreement with the previous research reports which reflected reduced feed intake in early restricted fed chickens (Crouch *et al.*, 2002a; Tumova *et al.*, 2002 and Mohebodini *et al.*, 2009). In support of the results of the current study, Sekoni *et al.* (2002) concluded that restricted fed chickens consumed 30 percent less feeds compared to *ad libitum* fed chickens.

During the laying phase, the performance of Koekoek chickens in terms of feed intake seemed to follow the same pattern except for the first two weeks of the laying period. The initial two weeks of the laying phase indicated that Koekoek chickens consumed significantly different feeds from one another. As presented in Table 4 the results demonstrated that chickens that were in AA treatment had higher ($P<0.05$) consumption of feeds (100.70g/day) at the age of 19 weeks followed by Koekoek chickens in treatments RA, AR and RR with the daily feed intakes of 88.90g, 85.01g and 73.49g per bird respectively and all treatments were different ($P<0.05$) from one another. At the age of 20 weeks, birds in RA treatment had highest ($P<0.05$) feed consumption of 117.00g with a Koekoek chicken in AA treatment registering a feed intake of 115.00g in a day. The birds in AR and RR treatments ate 83.70g and 83.90g respectively in a day per bird. The feed intake between Koekoek chickens in AR and RR treatments was insignificant. The results of this study clearly showed that from the age of 21 weeks to the end of the experiment chickens that were fed restrictedly had on average lower ($P<0.05$) daily feed intake of 84g per Koekoek chicken compared to Koekoek chickens that were fed without a limit with an average daily feed intake of 117g per bird.

Table 4: Feed intake per day (g/d) of Koekoek chickens that were subjected to different levels of feeding

Age (wks)	Treatment				S.E
	AA	AR	RA	RR	
Rearing phase (10 - 18 weeks) (Weights, g)					
10	54.23 ^a	54.35 ^a	42.83 ^b	42.00 ^b	0.143
11	59.83 ^a	59.79 ^a	43.03 ^b	43.03 ^b	0.003
12	63.47 ^a	63.47 ^a	46.00 ^b	46.00 ^b	0.007
13	66.57 ^a	66.54 ^a	48.00 ^b	48.00 ^b	0.007
14	70.82 ^a	70.86 ^a	49.01 ^b	49.00 ^b	0.011
15	79.99 ^a	80.00 ^a	56.00 ^b	56.00 ^b	0.002
16	79.64 ^a	79.59 ^a	56.02 ^b	56.02 ^b	0.043
17	81.35 ^a	81.19 ^a	57.04 ^b	57.04 ^b	0.074
18	82.97 ^a	83.00 ^a	58.00 ^b	58.00 ^b	0.010
8-18	4944 ^a	4940 ^a	3590 ^b	3585 ^b	1.500
Laying phase (19 - 32 weeks) (Weights, g)					
19	100.70 ^a	85.01 ^b	88.90 ^c	73.49 ^d	0.135
20	115.00 ^a	83.70 ^b	117.00 ^c	83.90 ^b	0.089
21	117.00 ^a	84.00 ^b	117.20 ^a	84.00 ^b	0.020
22	116.50 ^a	83.94 ^b	116.90 ^a	83.98 ^b	0.056
23	117.20 ^a	84.01 ^b	117.20 ^a	84.00 ^b	0.028
24	117.20 ^a	84.00 ^b	117.20 ^a	84.00 ^b	0.008
25	117.30 ^a	84.00 ^b	117.3 ^a	84.00 ^b	0.015
26	117.40 ^a	84.00 ^b	117.40 ^a	84.00 ^b	0.002
27	117.30 ^a	84.00 ^b	117.30 ^a	84.00 ^b	0.012
28	117.10 ^a	84.01 ^b	117.30 ^a	84.00 ^b	0.018
29	117.10 ^a	84.00 ^b	117.30 ^a	84.00 ^b	0.013
30	117.20 ^a	84.00 ^b	117.40 ^a	84.00 ^b	0.009
31	117.40 ^a	84.00 ^b	117.40 ^a	84.00 ^b	0.003
32	117.40 ^a	84.00 ^b	117.40 ^a	84.00 ^b	0.002
19-32	10530.00 ^a	7649.00 ^b	10470.00 ^c	7569.00 ^d	1.178
10-32	15480.00 ^a	12600.00 ^b	14060.00 ^c	11150.00 ^d	1.825

^{abcd} Means within a row with no common superscript differ significantly (P<0.05); AA-full feeding during rearing and laying, AR-full feeding during rearing and restricted during laying, RA-restricted feeding during rearing and full feeding during laying, RR-restricted during rearing and laying, S.E-standard error.

Koekoek chickens that were in RR treatment had lowest (P<0.05) total feed intake of 7.57 kg per bird during laying phase (19 to 32 weeks) with chickens in AA treatment having the highest feed intake (10.53 kg/bird). Koekoek chickens in RA and AR had the intermediates feed consumptions of 10.47 and 7.65 kg per chicken respectively but significantly different from one another (P<0.05). When considering the total amount of feed intake per bird from 8 to 32 weeks it can be observed as presented in Table 4 that Koekoek chickens raised on restricted feeding for the entire study (RR) ate significantly less (11.15 kg) compared to chickens in other treatments. Birds in AA treatment had highest (P<0.05) feed intake of 15.48kg per bird followed by Koekoek chickens that were in RA treatment with the total feed consumption of 14.06kg but significantly different from the birds in AA treatment. The birds that were in AR treatment had a total feed intake of 12.60 kg per bird. Birds in AA and RA treatments ate more (P<0.05) as compared to birds in AR and RR treatments during the laying phase. The results of this study are in agreement with Ukachukwu and Akapan (2007a) who stated that feed intake appears to be a reflection of the amount of feed made available to the various groups of birds based on the percentage of restriction imposed on each group. Chickens subjected to restricted feeding have reduced feed intake in comparison to birds raised on full feeding (Crouch *et al.*, 2002a).

Even though birds that were under AA and RA received the same amount of feed, birds under RA treatment increased their feed intake by 59.06g in a period of two weeks from 18 to 20 weeks while feed intake of birds in AA treatment increased their feed intake by 31.92g. These results are in agreement with the findings of Naraharl *et al.* (1975) which stated that birds which have been restricted during rearing and then allowed to feed *ad libitum* during laying display increased feed intake per day. The birds that were previously feed restricted and later shifted to *ad libitum* feeding tend to eat more due to an increased appetite of the birds (Eitan and Soller, 2001). In support of these results, Hassanabadi and Moghaddam (2004) reported that birds that were restricted at early stage of their development increased their feed intake rapidly in order to get into what the intake would have been if they were not restricted. CIWF (2003) indicated that feed restricted broiler breeders consume their feed in a very short space of time and are chronically hungry and this is demonstrated by the fact that they are strongly motivated to consume feed at all times.

The feed intake for Koekoek chickens that were transferred from full feeding to restricted feeding (AR) increased to 84g per day during the laying period being the 70 percent of the full feeding amount that was available to them. These results disagree with the findings of Krueger (1997) who indicated that birds that were transferred from *ad libitum* feeding to restricted feeding resulted in significantly reduced feed intake. The feed intake of Koekoek chickens in RR treatment agrees with Eitan and Soller (2001) as they suggested that feed intake of the restricted fed chickens' increases between 20-22 weeks of age in restricted fed birds and the same results were observed in the current study. Crouch *et al.* (2002a) made an observation that the feed intake of restricted fed birds resulted in a saving in terms of feed costs and this observation is being confirmed by the current study.

Results shown in Table 5 indicate the significant difference in FCR between Koekoek chickens that were full-fed (AA and AR) and the ones that were feed restricted (RA and RR) during the growing phase. Koekoek chickens that were in AA and AR treatments had feed conversion ratio of 3.46 and 3.51 respectively compared to the FCR of 4.19 and 3.99 for birds in RA and RR treatments respectively at the age of 10 weeks. The same trend of the results was observed throughout the growing phase and the only exception was at the 12th week of which the FCR difference between the different feeding levels was not significant although the birds on full feeding performed better. The similar trend of the results was also observed on overall (10 to 18 weeks) FCR of Koekoek chickens subjected to different feeding levels. The FCR scores for the full-fed chickens were 5.45 and 5.41 for Koekoek chickens in AA and AR treatments respectively which were better (P<0.05) than Koekoek chickens that were fed restrictedly which had feed conversion ratios of 6.79 and 6.68 for RA and RR treatments respectively. The results of this study suggested that full-fed chickens managed to convert feeds into body weight better than feed restricted chickens. The findings of this study are not in line with Farhat *et al.* (1986) who reported that restricted feeding resulted in

Table 5: Feed conversion ratio of Koekoek chickens that were subjected to different feeding level treatments

Age (weeks)	Treatment				S.E
	AA	AR	RA	RR	
Rearing Phase (10 -18weeks)					
10	3.46 ^a	3.51 ^a	4.19 ^b	3.99 ^b	0.05
12	3.66	3.68	3.92	3.96	0.05
14	5.44 ^a	6.46 ^a	7.25 ^b	7.44 ^b	0.20
16	5.41 ^a	5.06 ^a	8.04 ^b	7.75 ^b	0.09
18	4.99 ^a	4.71 ^a	6.25 ^b	6.28 ^b	0.10
10-18	5.45 ^a	5.41 ^a	6.79 ^b	6.68 ^b	0.60
Laying Phase (20-32weeks)					
20	7.38 ^a	11.84 ^b	4.44 ^c	6.15 ^d	0.17
22	9.91	-6.14	11.41	12.02	5.10
24	10.77 ^a	21.33 ^b	6.71 ^c	8.88 ^a	0.35
26	11.80 ^{ab}	27.15 ^c	9.51 ^a	12.35 ^b	0.46
28	22.33	15.72	7.33	14.83	3.63
30	47.83 ^a	-60.01 ^b	34.51 ^a	55.26 ^a	4.59
32	65.30	-6.59	8.39	-2.01	17.09
20-32	15.00 ^a	46.26 ^b	9.43 ^a	15.78 ^a	3.47
10-32	8.90 ^a	10.97 ^b	7.52 ^c	9.07 ^a	0.03

^{abcd} Means within a row with no common superscript differ significantly ($P < 0.05$); AA-full feeding during rearing and laying. AR-full feeding during rearing and restricted during laying, RA-restricted feeding during rearing and full feeding during laying, RR-restricted during rearing and laying, S.E-standard error.

Table 6: Mortality (%) of Koekoek chickens that were subjected to different feeding level treatments

Age	Treatments				S.E
	AA	AR	RA	RR	
10 – 18 weeks (rearing phase)	2.98	4.29	1.43	2.50	0.73
20 -32 weeks (laying phase)	2.51	1.59	1.59	1.85	0.57

slower feed passage rate (FPR) through digestive system hence an increase in the utilization of feed as feed restriction tends to lengthen the time in which the feeds are in contact with the enterocytes and as a result the nutrient absorption will improve.

During the laying phase Koekoek chickens that were in RA treatment had better ($P < 0.05$) feed conversion ratio from first oviposition (19 weeks) up to the end of the experiment (32 weeks) than chickens that were in other treatments (AA, AR and RR). When looking at the overall FCR for the laying period (19-32 weeks) it was observed that chickens that were subjected to RA treatment had efficient FCR (9.43) than chickens that were in other treatments at 5% significant level. Koekoek chickens that were allotted to AR treatment had the worse ($P < 0.05$) feed conversion ratio (46.26). The chickens in AA and RR treatments had the feed conversion ratios of 15.00 and 15.78 which were not significantly different from each other. The same ranking as in overall laying was reflected in the total feed conversion ratio (8 to 32 weeks) of Koekoek chickens as the FCRs for Koekoek chickens were 7.52, 8.90, 9.07 and 10.97 for birds in RA, AA, RR and AR treatments respectively. These results tend to agree with the findings of Farhat *et al.* (1986) who stated an increase in FCR when restricted feeding is followed by *ad libitum* feeding in chickens. Farhat *et al.* (1986) also mentioned that a feed restriction of 25 percent in layers would yield better results in terms of compensatory growth and feed conversion ratio.

The results indicates the differences in the number of deaths between Koekoek chickens that were fed without

restriction and the restricted fed chickens even though there were not different ($P > 0.05$).

During the growing phase (10 to 18 weeks), the total mortality in birds that were full-fed (AA and AR) was 7.27% while mortality of restricted fed Koekoek chickens (RA and RR) was 3.93%. Even though the results obtained from this study reflected the insignificant mortality rate of full-fed chickens compared to those that were allotted to restrict feeding it was noticed that full-fed chickens had 3.34% more death casualties than restricted fed Koekoek chickens. The results obtained from this study are in agreement with Tottori *et al.* (1997), Lippens *et al.* (2000) and Robert (2009) who indicated that feed restriction is effective in controlling mortality. Balnave (1984) also demonstrated that a feed restriction of 25 to 50 percent could reduce mortality in birds. The results of the current study suggest that a 30 percent feed restriction slightly lowered the mortality rate in Koekoek chickens. This slight decrease in the death rate of chickens that were under restricted feeding cannot be underestimated as this would a mean a lot to a subsistence farmer at the rural village in Lesotho.

During the laying phase, the death rates in Koekoek chickens were 2.51, 1.59, 1.59 and 1.85% for birds in treatments AA, AR, RA and RR respectively. As observed in Table 6, Koekoek chickens that were full-fed for the entire study (AA) had insignificantly higher number of dead chickens compared to birds that were in other treatments. Even though the differences in the mortality rate of the birds in different treatments were not significant, the higher percentage of mortality in full-fed chickens could possibly result from high body weight which is associated with pathological conditions and metabolic disorders like ascites as stated by Tolkamp *et al.* (2005). Farhat *et al.* (1986) and Mahmood *et al.* (2007) indicated that feed restriction might be helpful in lowering the incidences of acites in chickens and hence reducing the mortality rate. CIWF (2003) stated that *ad libitum* fed breeding chickens are prone to obesity, thermal discomfort, lameness as well as skeletal disorders, heart failure and excessive body weight which are all associated with reduced disease resistance. Naraharl *et al.* (1975) stated that mortality is reduced from 19.3 to 10.5% in crossbred strains when *ad libitum* feeding is followed by restricted feeding. Lippens *et al.* (2000) suggested that a mild restriction might offer economic advantages by decreasing mortality; they revealed that apart from reduction in mortality applying feed restriction in layers has been approved to result in better feed conversion efficiency.

Conclusion

Koekoek chickens that were full-fed during the first part of the study (rearing phase) had heavier body weight, weight gain, feed intake as well as FCR compared to those that were subjected to restricted feeding. During the second phase of the study (laying phase) the live body weight performance of Koekoek chickens differed from one another with birds in RA treatment being heavier than Koekoek chickens in AA, AR and RR treatments. The FCR records show that chickens that were subjected to restricted feeding only in the laying phase (AR) were poor in converting feed into weight while the best FCR was

seen in chickens that were in RA treatment followed by that were in AA and RR treatments. Therefore, 70% feed restriction during the rearing phase followed by full feeding in the laying phase (RA) appears to be the most profitable strategy with respect to high body weights during the laying period without necessarily effecting egg production. It was also cheaper to start with restricted feeding followed by full feeding as compared to feeding chickens without restriction for the entire period. The feeding level did not have any effect on the mortality rate of Koekoek chickens.

It is therefore recommended that farmers who intend to keep Koekoek chickens beyond 18 weeks to feed them restrictedly during the rearing and shift to full feeding during laying phase (RA). In a case where chickens are reared exclusively for human consumption (meat) full feeding (AA and AR) in the rearing phase would be the best feeding management option.

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