CHAPTER 4

Effect of restricted feeding level and season on the carcass chemical composition of Koekoek chickens

Abstract

The main objective of this study was to determine the effect of restricted feeding and season on carcass chemical composition of Koekoek chickens. Two hundred and seventy hens and 27 cocks were used. An experiment was designed as a factorial of two seasons and four feeding regime treatments. The four treatments were AA, AR, RA and RR. Each treatment had seven replicates (10 birds per replicate) with an exception of RR treatment that was replicated six times (10 birds per replicate). Data was collected at 18 and 32 weeks of age. Data collected was subjected to SPSS (17.00) statistical package and analyzed by using multi- factorial analysis of variance (ANOVA). At the age of 18 weeks, feed restriction had an impact on dry matter, fat and crude protein percentage. At 32 weeks of age, birds that were fed restrictedly had reduced fat content and increased crude protein. The lowest crude protein percentage was recorded in chickens that were full-fed for the entire study (AA). Chickens that were allotted to summer treatment had a higher dry matter and crude protein content than chickens that were in winter treatment at 18 weeks of age. Koekoek chickens that were in summer and winter treatments performed differently in terms of dry matter, ash, crude fat and crude protein percentages at the age of 32 weeks. It is therefore, concluded that restricted feeding coupled with rearing chickens in winter resulted in lean carcass with more protein.

Key words: Koekoek chickens, feed restriction, full-fed, temperature, season, chemical composition.

4.1 Introduction

Increase in population in developing countries has not been marked by growth in agricultural productivity in the area of animal production, which leads to hunger and serious malnutrition among the people (Ukachukwu and Akpan, 2007). Basotho consume an average of 15g of animal protein per day as compared to 54g per capita per day in America and Europe. This is grossly inadequate and poses a threat of serious malnutrition (Jennings, 1974). Currently the high cost of poultry products makes it impossible for an average family in the country to consume an adequate quantity of animal protein.

These price increases are a reflection of corresponding high costs of feeds that result in low production and short supply of poultry.

The ash content was reported to be similar in the *ad libitum* and restricted fed chickens (Renema *et al.*, 1999a). Renema *et al.* (2007) explained that the percentage of crude fat in poultry meat is dependent on the severity of early feed restriction. In a study conducted by Crounch *et al*. (2002c) it was observed that carcass fat was reduced in restricted fed turkeys.

Higher moisture content was reported in chickens' meat produced in summer (Bianchi *et al.*, 2007). However, the results of Aksit *et al.* (2006) pointed to lower moisture content in chickens' thighs that were reared under increased environmental temperature while Barbour *et al.,* (2010) reported non-significant differences between the two groups of chickens. Summer conditions retarded the protein level in chickens (Aksit *et al.*, 2006 and Bianchi *et al.,* 2007). Bianchi *et al.* (2007) reported a lower ash percentage in summer reared chickens than in winter. The carcass fat was higher in chickens that were exposed to higher temperatures or summer conditions (Bogosavljevic- Boskovic *et al.*, 2006; Bianchi *et al.*, 2007; Rosa *et al.*, 2007 and Barbour *et al.,* 2010).

In order maintain meaningful and sustainable poultry production, it is necessary to find out the means of producing the acceptable quality of chicken meat at reduced costs in different seasons. An alternative feed management practice that would address this issue becomes imperative hence why this research project was focused on the effects of feed restriction and season on carcass chemical composition of Koekoek chickens. With the information obtained from this study, the farmers would be in a position to choose the appropriate feeding level and season so as to reduce the feeding costs without compromising the quality of meat from Koekoek chickens.

4.2 Materials and Methods

Two hundred and seventy (270) hens and twenty-seven (27) cocks of Koekoek chickens were bought at eight weeks of age. The chickens were housed in twenty-seven (27) pens. Ten hens and one cock were randomly selected and placed in each pen. The chickens were given a stress pack in water to combat travelling stress and lasoda vaccine in water to prevent Newcastle disease they might incur from travelling. They were fed pullet grower mash from arrival day up to 18 weeks of age, and then fed laying mash from 19 to 32 weeks. Koekoek chickens under restricted feeding were fed 70% of the full-fed diet. Koekoek chickens were offered fresh water without restriction and fed the same commercial feeds but at different quantities per day. The experiment was designed as a 4 feeding levels × 2 seasons (summer and winter) factorial arrangement in a completely randomized design. Treatments comprised: AA (Chickens were full-fed during both rearing and laying phases), AR (Chickens were full-fed during the rearing phase and shifted to restricted feeding during the laying phase), RA (Chickens fed restrictedly during the rearing phase and shifted to full feeding during the laying phase) and RR (Chickens fed restrictedly during both rearing and laying phases). Treatments AA, AR and RA were replicated seven (7) times except treatment RR, which was replicated six (6) times. Therefore, there were twenty-seven (27) experimental units.

At 18 and 32 weeks of age, one Koekoek chicken (hen) per replicate was slaughtered from chickens that were allocated to AA, AR, RA and RR treatments. Birds were starved for 12 hours before slaughtering. The slaughtering procedure was followed as outlined by Jones (1984). Following the weighing and measuring of organs and tissues, they were returned to their respective individual carcasses and stored at -40^{o}C. The carcass composition was carried out on birds without feathers with all carcass components. Thawed carcasses were dissected and then emptied into the blender (mincer) to be homogenized. The duplicate sample (200g) of each homogenate was freeze dried and then ground. The ground sample was then chemically analyzed for dry matter, protein, fat and ash (Van Marle Koster and Webb, 2000). The procedure for the chemical analysis of ground carcasses was as follows:

i) Dry Matter Chemical Analysis

Crucibles were cleaned and dried in a 105^{o}C oven for two hours. They were then placed in a deciccator for about 20 minutes in order to cool them to a room temperature. Two (2) grams of the grounded homogenous meat sample was weighed into the crucibles and each sample treatment was duplicated. The meat samples were placed in an oven for five (5) hours. The crucibles with meat samples were then removed from an oven and were placed again in a desiccator to cool to room temperature. The samples together with crucibles were then weighed back. The following formula was used to calculate the percentage of dry matter.

$$\% \text{ Dry Matter} = \frac{\text{(crucible weight + weight of the oven dried sample)}}{\text{Weight of sample before oven dried}} * 100$$

ii) Ash chemical analysis

The crucibles were placed in a muffle furnace of 350^0C for an hour. The temperature of the muffle furnace was then increased to 600^0 C for five hours. The crucibles were left in the muffle furnace over-night to cool down. They were then transferred to the desiccator to cool to room temperature. The following formula was used to calculate the ash percentage as dry basis:

$$\%Ash\ as\ dry\ basis = \frac{Weight\ of\ ash}{Weight\ sample * \%DM} *100$$

iii) Determining crude protein percentage using Leco FP-428

The leco FP- 428 is a microprocessor based using software controlled instrument that determines the nitrogen in variety of materials (Leco instruction manual). The ground meat sample weighing 0.2g was measured into the foil cup. The analysis cycle was composed of three (3) phases. During the drop purge phase, the encapsulated sample was placed in the loading head, sealed and purged of any atmospheric gases.

During the burning phase, the sample was dropped into a hot furnace of about 950^oC. It was then flushed with pure oxygen for very rapid combustion. The main products of combustion namely CO_2, H_2O, NOx and N_2 were passed through the thermo-electric cooler to remove most of the water then collected in the ballast volume. The products in the ballast were allowed to become a homogenous mixture at a pressure of approximately 975mm and at a constant temperature. In the third phase, the piston was forced down and a 10cc aliquot of the sample mixture was collected. The sample aliquot was swept through hot copper to remove oxygen and change NOx to N_2, then through lecosorb and anhydrone to remove carbon dioxide and water respectively. Finally, the remaining combustion product being nitrogen was measured using a thermal conductivity cell. The final product was then displayed as percent protein.

v) Determination of fat content

The crude fat percentage was determined with reference to Fat (Crude) or Ether Extract in Animal Feed (Method no 920.29, AOAC,, 1990). Two (2) grams of duplicated homogenous ground meat sample were weighed into tarred filter papers. The filter papers were folded and inserted into pre-numbered thimbles. The numbered fat cups (beakers) were dried in a 105^oC oven and then cooled in a desiccator.

The fat cups were lined up in front of the extractor to match the thimbles with their corresponding fat cups. The thimbles were slipped into the thimble holder that was clipped into position on an extractor. The fat cups were filled with petroleum ether (b.p. 40-60^{o}C) to the three quarter level. The beakers were clamped into an extractor. The heater switch, main power switch and condenser water were turned on. It was ensured that the ether did not leak. Extraction was allowed for four (4) hours. Rinsing was then allowed for an hour. The cups were detached from the extractor to allow for ether distillation. The distillation was done until a thin layer of ether remained at the bottom of the cups. The fat cups were then taken to the oven for 30 minutes. Finally, the cups were placed in a desiccator for cooling and then weighed again. The formula used to determine the percentage of crude fat was as follows:

$$\% \text{ crude fat} = \frac{\text{cup + extracted fat – cup weight}}{\text{Sample weight}} * 100$$

Data obtained and collected were stored in the computer under Microsoft excel and then finally analyzed using multi-factorial analysis of variance with the aid of SPSS (17.00) statistical package. Analyses were done on the transformed data. The same study was done in summer and winter.

4.3 Results and Discussion

The results for the chemical composition of the meat from chickens that were subjected to different feeding treatments at different slaughter ages are presented in Table 4.1. The results indicate that chickens that were subjected to different feeding levels performed differently in some of the nutrients. Koekoek chickens that were full-fed during the rearing phase (18 weeks) had a dry matter content of 96.7% and 96.9% for chickens that were in the AA and AR treatments respectively. Chickens that were subjected to restricted feeding had a dry matter content of 89.1% and 90.1% for those in the RA and RR treatments respectively. The dry matter content of chickens that were full-fed was higher ($p<0.05$) than the one in the feed restricted chickens by 7.4%.

At the age of 32 weeks, the dry matter content of chicken meat in the AA treatment was 0.7%, 0.8 and 0.8% lower ($p<0.05$) than in the AR, RA and RR treatments respectively. The findings of this study clearly indicate that the dry matter content failed to respond positively to body weight in chickens that were in the AA treatment at 32 weeks of age. It was also observed that the dry matter content of chickens that were full-fed in the rearing phase (AA and AR) declined during the laying phase while the dry matter of chickens that were feed restricted during the rearing phase (RA and RR) increased during the laying phase.

Table 4.1: Dry matter, ash, crude fat and crude protein percentages of meat from Koekoek chickens that were subjected to different feeding level treatments

		Treatments				
Age wks	**Nutrient (%)**	**AA**	**AR**	**RA**	**RR**	**S.E**
18	DM	96.7[a]	96.9[a]	89.1[b]	90.1[b]	0.24
	Ash	8.7	8.6	8.6	8.2	0.11
	Fat	43.4[a]	41.5[a]	33.5[b]	32.7[b]	0.47
	CP	37.9[a]	40.8[a]	50.0[b]	50.8[b]	0.57
32	DM	95.2[a]	95.9[b]	96.0[b]	96.0[b]	0.10
	Ash	6.1	6.2	6.1	6.3	0.15
	Fat	51.9[a]	45.3[b]	50.2[a]	40.0[c]	0.69
	CP	39.7[a]	41.9[ab]	41.8[ab]	45.1[b]	0.67

[ab] Means within a row with no common superscript differ significantly ($p<0.05$).
Footnote:
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. DM=Dry matter, CP=Crude protein

These results are in agreement with the results of Robinson *et al.* (1991b) who reported a significantly higher dry matter percentage in the full-fed chickens than in restricted fed chickens. Contrary to the results of the present study in the laying phase, Sobina *et al*. (1999) showed that chickens that are subjected to restricted feeding over a long period of time would show a significant decrease in the percentage of dry matter and fat.

Chickens that were kept in summer during the rearing phase (18 weeks) had a higher ($p<0.05$) dry matter percentage (94.1%) than those that were allocated to winter conditions (92.2%). This shows that the dry matter content of chickens that were reared in summer was 2% higher than in winter. During the laying phase (32 weeks), there was a significant difference in the percentage of dry matter observed between Koekoek chickens that were reared in summer and winter. Birds in summer improved the dry matter percentage by 1%. It was also observed that the dry matter content increased with the increase in the age of chickens. This can be confirmed by the fact that the dry matter content increased by 2.2% and 3.2% in chickens that were exposed to summer and winter condition respectively between 18 and

32 weeks of age. This indicates that a higher dry matter content in chickens that were kept in summer was possibly due to the higher weights that chickens experienced in summer.

The results of the present study are in accordance with the findings of Aksit *et al.* (2006) who noted that chickens that were raised under a higher temperature had a lower moisture content compared to those that were raised under a lower temperature. Contrary to the results of the present study, Chen *et al.* (2007) found no differences between the moisture content of chickens that were subjected to different sunlight hours in a day. Barbour *et al.* (2010) also reported non-significant differences in the moisture content of chickens that were exposed to different temperatures. Contrary to the findings of the present study, Bianchi *et al.* (2007) concluded that chicken meat produced in summer had higher moisture content.

The results portray that the dry matter percentage in chickens that were subjected to the restricted feeding in winter was 4.1% less than ($p<0.01$) in summer (Table 4.3). The feeding level and season interaction results clearly show that the differences in the dry matter were mainly due to the different slaughter weights that were noticed to be higher in summer at the age of 18 weeks.

The feeding level failed to affect the carcass ash contents in Koekoek chickens. The insignificant differences show that the carcass ash content was not related to the slaughter weight, hence there is a non-significant correlation (r= 0.076) between the ash content and slaughter weight. The ash percentage had an insignificant negative correlation (r= -0.11) with the slaughter weight. The carcass ash content had no significant correlation with crude protein, fat and dry matter percentages. This means that the ash content cannot be estimated by relating it either to body weight or to any of the nutrients. The results also show a decline of 27.5% in ash content across all treatments from 18 to 32 weeks of age meaning that that the older the chickens the lesser the ash content. The results of the present study are in agreement with the findings of Renema *et al.* (1999a) who reported similar ash content between full fed and restricted fed chickens.

At the age of 18 weeks as shown in Table 4.2, chickens that were kept in summer and winter obtained a similar (8.5%; $p>0.05$) meat ash contents. During the laying phase (32 weeks), the results indicate that the cold winter conditions improved the content of ash by 4.4%. This clearly shows that the ash content was negatively associated with the slaughter weight of chickens in a manner that meat from chickens with heavier body weights had a lower ash content.

It was also observed that the meat ash content decreased with an increase in age. The ash content from chicken meat produced in summer and winter treatments deteriorated by 29.1% and 26% respectively. This shows that the meat ash quality was negatively affected by high temperatures in summer rather than by low temperatures in winter. This means that low temperatures in winter were able to preserve the mineral and the vitamin components in chicken meat.

The results of the present study are in line with the findings of Aksit *et al.* (2006) who reported that the ash content seemed to decrease with an increase in age. The results by Bianchi *et al.* (2007) also stated that chicken meat produced in winter had a higher ash content compared to that produced in summer. Persia *et al.* (2003) found that the tibia ash percentage in chickens' meat was not affected by high temperature and this was not in agreement with the finding of the present study. Contrary to the results of the present study, Chen *et al.* (2007) disclosed that the relative ash percentage is not influenced by the different photoperiods.

An average crude fat percentage of chickens that were full-fed (AA and AR) was higher ($p<0.05$; 42.5%) than the one of Koekoek chickens that were feed restricted (RA and RR) with an average fat content of 33.1% at the age of 18 weeks. The findings imply that heavier chickens at slaughter age had higher crude fat percentage. This can be confirmed by a positive ($p<0.01$) correlation ($r=0.635$) between the slaughter weight and crude fat percentage. The crude fat percentage also had a positive correlation ($r=0.682$) with the dry matter percentage while the opposite was true with the crude protein percentage ($r= -0.627$; $p<0.01$).

At the age of 32 weeks, birds that were in the AA treatment had a higher fat content than those in the AR, RA and RR treatments by 6.6, 1.7 and 11.9% respectively. These results suggest a small difference between the crude fat percentage from AA and RA treatments as opposed to the AR and RR treatments. It was also observed that the crude fat content increased, as chickens were getting older across all the feeding level treatments. Chickens in the RA treatment had a highest increase compared to chickens in other treatments while those in the AR treatment had the lowest fat accumulation from 18 to 32 weeks of age. The highest crude fat percentage obtained from chickens that were in the RA treatment could possibly be attached to the compensatory growth shown by the same group of chickens.

The results of the present study are in accord with the findings of Renema *et al.* (1999a) who stated that the higher crude fat content was found in birds with heavy body weights compared to lower body weight chickens. Crounch *et al.* (2002c) also indicated that turkeys that were feed restricted had lower crude fat during rearing when compared to those that were full fed. Hassanabadi and Moghaddam (2004) concluded that the carcass fat content of restricted fed broiler chickens was lower ($p<0.05$) than that of control fed birds. Robinson *et al.* (1999) also indicated that carcass lipid remained significantly greater in the *ad libitum* fed broiler breeders than in the restricted fed ones.

Chickens reared in summer had insignificantly higher crude fat percentage (37.9%) than winter-reared ones (37.7%) during the rearing phase. The differences ($p<0.05$) in the percentage of crude fat were observed at the age of 32 weeks between chickens that were reared in summer and winter. Koekoek chickens that were in winter treatment outperformed their counterparts in summer by 6.7% in terms of crude fat content. The crude fat percentage increased with age despite of the season in which chickens were produced. Chickens that were subjected to summer conditions accumulated 7.7% while those raised in winter accumulated 10.6% of the crude fat between 18 and 32 weeks of age.

The results in the rearing phase (18 weeks) are supported by the findings of Chen *et al.* (2007) who reported non-significant differences in the total fat content of chickens that were subjected to different photoperiods. On the other hand, Bianchi *et al.* (2007) and Bogosavijevic-Boskovic *et al.* (2006) recorded higher lipid content in chickens that were kept in summer as opposed to those kept in winter. Barbour *et al.* (2010) also confirmed that birds that were heat acclimatized had a higher percentage of fat than those that were not exposed to heat. A higher crude fat percentage in chickens that were raised in winter is believed to be the outcome of high feed intake that resulted in more fat accumulation.

Koekoek chickens that were full-fed during the rearing phase obtained a lower percentage of crude protein (39.4%) while those that were raised under feed restriction had a crude protein of 50.4%. This indicates that an average crude protein percentage of restricted fed chickens was higher than the one of full-fed chickens by 21.9%. These results illustrate that chickens with a high body weight and fat content had reduced crude protein content hence why the crude protein is negatively correlated ($p<0.01$) with the slaughter body weight ($r = -0.467$), crude fat content ($r = - 0.627$), dry matter content ($r= -0.553$) and ash ($r = -0.295$; $p<0.05$).

At the age of 32 weeks, Koekoek chickens that were full-fed for the entire study (AA) obtained a lower ($p<0.05$) percentage of crude protein (39.7%) than those that were exposed to feed restriction for the entire study (RR) which had the highest protein content (45.1%). The crude protein percentages in the AR (41.9%) and RA (41.8%) treatments were statistically ($p>0.05$) similar and were different ($p<0.05$) from chickens that were in the AA and RR treatments. The results also showed a negative ($p<0.01$) correlation ($r= -0.547$) between the slaughter weight and crude protein.

The findings of the current study show that the crude protein percentage of chickens that were in the AR treatment increased by 2.8% while the one of chickens that were in the RA treatment declined drastically by 16.4%. Koekoek chickens that were full-fed for the two phases increased their protein content by 5.2% from 18 to 32 weeks of age. The protein percentage of chickens that were exposed to restricted feeding for the whole study (RR) decreased by 11.1%. These results indicate that despite chickens in restricted feeding having higher protein content there is a possibility of a decline in the crude protein percentage if they are slaughtered at an older age. This was also confirmed by de Beer and Coon (2007) who stated that the carcass protein content generally decreases with age in chickens.

The results of the present study are related to the findings of Renema *et al.* (1999a) who reported the similar percentages of protein in chickens that were in different feeding regimes, a the similar pattern to results observed in this study at 32 weeks of age.

The protein content of Koekoek chickens that were in summer treatment was 6.8% higher than in winter at the age of 18 weeks. The protein content responded positively to the body weight of chickens hence the meat produced from heavier chickens in summer yielded higher crude protein content. An opposite pattern of results was observed in chicken meat at the slaughter age of 32 weeks. Koekoek chickens that were exposed to winter conditions had a higher ($p<0.05$) crude protein content (46.2%) as compared to the ones that were subjected to summer treatment (38%). These results demonstrate that chickens with higher body weights had a lower crude protein percentage. It was also observed that the meat crude protein content of chickens that were exposed to warm summer conditions declined by 18.1% over a period of 14 weeks while the protein content in winter increased by 6.4%. These results reflect that the meat of chickens produced in summer deteriorates in value more than in winter as chickens get older.

The results of the present study are supported by the findings of Bianchi *et al.* (2007) and Blahova *et al.* (2007) who pointed out that the protein level was lower in chicken meat that was produced in summer, as was the case in this study, especially at the slaughter age of 32 weeks. Aksit *et al*. (2006) and Rosa *et al.* (2007) also argued that protein content corresponded negatively with the amount of heat allotted to chickens. Contrary to the findings of this study, other researchers reported a similar performance in chickens that were exposed to different temperatures (Chen *et al*., 2007 and Barbour *et al.*, 2010).

Table 4.2: Dry matter, ash, crude fat and crude protein percentages of meat from Koekoek chickens that were reared in either summer or winter

		Season		
Age (wks)	**Nutrient (%)**	**Summer**	**Winter**	**S.E**
18	DM	94.1[a]	92.2[b]	0.48
	Ash	8.5	8.5	0.21
	Fat	37.7	37.9	0.94
	CP	46.4[a]	43.3[b]	1.15
32	DM	96.2[a]	95.3[b]	0.19
	Ash	6.0[a]	6.3[a]	0.30
	Fat	45.2[a]	48.5[b]	1.37
	CP	38.0[a]	46.2[b]	1.36

ab Means within a row with no common superscript differ significantly (p>0.05), S.E- Standard Error

Table 4.3: Effect of the interaction between feeding level and season on the chemical composition of meat from Koekoek chickens

Meat chemical composition	SAA	S.E	WAA	S.E	SAR	S.E	WAR	S.E	SRA	S.E	WRA	S.E	SRR	S.E	WRR	S.E
% DM	97.0[a]	0.62	96.4[b]	0.62	96.5[a]	0.62	97.2[b]	0.62	91.7[a]	0.62	86.6[b]	0.62	91.3[a]	0.67	88.8[b]	0.62
% Ash	8.5	0.22	8.8	0.22	8.7	0.22	8.5	0.22	8.4	0.22	8.7	0.22	8.4	0.24	8.0	0.24
% Fat	43.5	1.30	43.4	1.30	43.1	1.30	40.0	1.30	32.9	1.30	34.1	1.30	31.5	1.41	34.0	1.41
% CP	39.4	1.41	36.5	1.41	42.3	1.41	39.2	1.30	53.5	1.41	46.5	1.41	50.6	1.52	51.0	1.41
% DM	96.1	0.27	94.3	0.27	96.3	0.27	95.5	0.27	96.3	0.27	95.7	0.27	96.2	0.29	95.7	0.29
% Ash	5.9	0.41	6.4	0.41	5.5	0.41	6.9	0.41	6.1	0.41	6.0	0.41	6.7	0.44	6.0	0.44
% Fat	47.8	1.88	56.0	1.88	43.0	1.88	47.5	1.88	49.7	1.88	50.7	1.88	40.5	2.05	39.6	2.05
% CP	35.7	1.86	43.7	1.86	39.9	1.86	43.9	1.86	35.8	1.86	47.8	1.86	40.8	2.01	49.5	2.01

[ab] Means within a row with no common superscript differ significantly (p<0.05 and p<0.01).

Footnote:

SAA- full feeding during rearing and laying in summer season. SAR- full feeding during rearing and restricted during laying in summer season, SRA-restricted feeding during rearing and full feeding during laying in summer season, SRR-restricted during rearing and laying in summer season, WAA- full feeding during rearing and laying in winter season. WAR-*ad libitum* feeding during rearing and restricted during laying in winter season, WRA-restricted feeding during rearing and full feeding during laying in winter season, WRR-restricted during rearing and laying in winter season, S.E-standard error, Sig- Significance level. %DM- Percentage Dry matter, % Ash- Percentage Ash, %Fat-Percentage fat, %CP-Percentage crude protein

4.4 Conclusion

- Full feeding increased the dry matter, ash and fat content while feed restriction improved the crude protein content of chickens during the rearing phase.
- Restricted feeding resulted in reduced fat accumulation and increased crude protein content in Koekoek chickens when slaughtered at the age of 32 weeks.
- Warm summer conditions improved the dry matter and crude protein contents during the rearing phase.
- Cold winter conditions during the laying phase increased the ash, fat and crude protein contents of chickens but lowered the dry matter percentage. Cold winter conditions have the potential of preserving the nutrient composition of chicken meat.

5.5 Recommendations

- In order to have chicken meat with higher protein content and low fat content it is recommended that Koekoek chickens be raised on feed restriction if a farmer is aiming at producing meat from 18 weeks old chickens.
- For farmers who are interested in chicken meat with higher protein and lower fat contents at the end of the laying phase the best feeding management would that the chickens be fed restrictedly for both rearing and laying phases (RR). The meat produced from chickens that were in the RA and AR treatments cannot be ruled out because of its higher crude protein except that it cannot be recommended to people with a problem in consuming fatty meat.
- It is also recommended that the best season to rear Koekoek chickens is summer if the target is to slaughter them at the age of 18 weeks based on the higher crude protein and dry matter contents.
- In a case where chickens would be slaughtered at an older age (32 weeks) it would be advantageous to keep them in winter so as to obtain higher ash (mineral and vitamin content) and crude protein percentages although a farmer would be compromising on the level of fat content which will not be a problem in winter since the human body needs that fat to generate warmth during the colder seasons.

4.6 References

Aksit, M., S. Yalcin, S. Ozkan, K. Metin and D. Ozdemir. 2006. *Effects of temperature during rearing and crating on stress parameters and meat quality of broilers*. Poultry Science 85: 1867-1874.

Association of Official Analytical Chemists. 1990. *Official methods of analysis*. 13th Ed. Association of Official Analytical Chemists, Washington DC.

Barbour, E.K., I. Tayeb, H. Shaib and I.M. Abrahim. 2010. *Physiological and carcass traits in heat stressed broilers differing in heat acclimatization, chemical or feed restriction treatments.* Agriculture and Biology journal of North America.1 (2): 65-74

Bianchi, M, M. Petracci, F. Sirri, E. Folegatti, A. Franchini and A. Melazzi. 2007. *The influence of season and market class of broiler chickens on breast meat quality traits*. Poultry Science 86: 959-963.

Blahova, J, R., Dobsikova, E. Strakova and P. Suchy. 2007. Effect of low environment temperature on performance and blood system in broiler chickens (Gallus domesticus). ACTA vet 76: S17-S23.

Bogosavljevic- Boskovic S., V. Kurcubic, M. Petrovic and V. Doskovic. 2006. *The effect of season and rearing system on meat quality traits*. Czech Journal of Animal Science 51:369-374.

Chen, H. R.L., Huang, H.X. Zhang, K.Q. Di, D. Pan and Y.G. Hou. 2007. *Effects of photoperiod on ovarian morphology and carcass traits at sexual maturity in pullets.* Poultry Science. 86: 917-920.

Crounch, A.N., J.L. Grimes, V.L. Christensen, and K.K. Kruegert. 2002c. *Effect of physical restriction during rearing on large white turkey breeder hens. 3. Body and carcass composition*. Poultry Science 81: 1792-1797.

de Beer, M., and C.N. Coon. 2009. *The effects of different feed restriction programs and dietary l-carnitine supplementation on hepatic lipogenesis, plasma heterophil to lymphocyte ratio and yolk content of broiler breeder hens.* International Journal of Poultry Science 8 (4): 328-341.

Hassanabadi, A and H. Nassiri Moghaddam. 2004. *Effect of early feed restriction on performance characteristics and serum thyroxin of broiler chickens*. International Journal of Poultry Science 5 (12): 1156-1159.

Jennings, (1974). *Farming Practice*. Longmans Publishing Co. London. Page 152-157.

Persia, M.E, P.L. Utterback, P.E. Biggs, K.W. Koelkebeck and C.M. Parson. 2003. *Interrelationship between environmental temperature and dietary nonphytate phosphorus in laying hens.* Poultry Science. 82: 1763-1768.

Renema, R. A., F.E. Robinson, M. Newcombe and R.I. McKay. 1999a. *Effect of body weight and feed allocation during sexual maturation in broiler breeder hens. 1.Growth and carcass characteristics*. Poultry Science. 78: 619-628.

Renema R.A., F.E. Robinson, and M.J. Zuidhof. 2007. *Reproductive efficiency and metabolism of female broiler breeders as affected by genotype, feed allocation, and age at photo stimulation. 2. Sexual maturation.* Poultry Science 86: 2267-2277.

Robinsin, F.E., N. A. Robinson, T.A. Scott. 1991b. *Reproductive performance, growth rate and body composition of full- fed versus feed restricted broiler breeder hens.* Can J. Animal Science. 71:549-556.

Robinson, F.E., T.A. Wautier, R.T. Hardin, J.L. Wilson, M. Newcombe and R. I. Mckay. 1999. *Effects of age at photostimulation on reproductive efficiency and carcass characteristics.* Canadian Journal of Animal Science 76: 283-288.

Rosa , P.S., D.E Faria Filho, F. Dahlke, B.S. Viera, M. Macari and R.L. Furlan. 2007. *Performance and carcass characteristics of broiler chickens with different growth potential and submitted to heat stress*. Brazilian Journal of Poultry Science. 9(3): 181-186

Sobina, I., M. Janiszewska and J. Kondratowicz. 1999. *Effect of periodical feed restriction on some physicochemical and sensory parameters of meat quality in white Italian geese*. Polish Journal of Natural Sciences 5: 199-210.

Ukachukwu, S.N. and U.O. Akpan. 2007. *Influence of level and duration of quantitative feed restriction on post-restriction egg-laying characteristics and egg quality of pullets*. International Journal of poultry Science 6: 567 – 572.

Van Marle- Köster E. and E.C. Webb. 2000. *Carcass characteristics of South African native chicken lines.* South African Journal of Animal Science 30: 53-56