Evaluation of Carcass Characteristics and Egg Quality Traits of Kuroiler and Sasso Chickens Reared Under On-Station and On-Farm Management Conditions in Tanzania

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Abstract

Two studies were conducted to evaluate the carcass characteristics and egg quality traits of Sasso and Kuroiler chickens under on-farm and on-station management conditions. Carcass characteristics were evaluated under on-station only while egg quality was evaluated under both management conditions. A total of 240 hens and 240 cocks were raised under on-station condition and evaluated for egg and carcass quality respectively. Meanwhile, 320 hens were raised under on-farm condition and evaluated for egg quality only. At the end of each of the 16th and 20th weeks of age, a sample of 10 cocks per breed was randomly selected and sacrificed for carcass traits evaluation. To study egg quality, a total of 666 fresh eggs (246 eggs from on-farm and 420 eggs from on-station) were used to evaluate the external and internal egg quality traits. The recorded data were analyzed using the General Linear Models (GLM) procedure of SAS software (SAS 2009). The results show that except for shell, yolk and albumen ratios, the mean values of other egg quality traits studied were higher for on-station than on-farm. Kuroiler chickens had higher values for egg weight, egg length, yolk weight, albumen height and Haugh unit than Sasso chickens. Live weight, carcass weight and carcass parts weight were found to be higher for Sasso than for Kuroiler at both ages of slaughter. It is concluded that there are variations between managements and breeds on egg quality traits. Carcass characteristics are affected by both breed and slaughter age.

Introduction

Poultry production in the world has undergone an enormous expansion and development during the last four decades. Advances in genetics, nutrition and husbandry have contributed to substantial improvement in poultry productivity which resulted in high consumption of poultry meat and eggs globally (Magdelaine et al. 2008; Kearney 2010). The poultry industry in Tanzania comprises both commercial and traditional sub-sectors. The traditional sub-sector is dominated by indigenous poultry in particular chickens. These chickens have low productivity characterized by three laying cycles per annum with 12 eggs per cycle. It is estimated that only 5% of these eggs are marketed and the rest are retained for hatching and household consumption (BFAP and SUA 2018).

Commercial poultry production is mostly practised in urban and peri-urban areas and it contributes a significant amount of poultry meat and eggs consumed in urban areas. However, the expansion of commercial chicken production in Tanzania is constrained by the inadequate supply of high performing chicken stocks. In general, the high-yielding chicken breeds had been bred solely for meat or table eggs, thus they require a high level of inputs in terms of nutritional and health management, to fully express their genetic potential (FAO 2014). The introduction of improved breeds such as Kuroiler and Sasso chickens, which are known to produce more meat and eggs than their counterpart local chickens, is an attempt to improve traditional poultry production in Tanzania. These dual-purpose chickens can thrive well in a typical scavenging free-range system and are less costly compared to specialized layers and broilers and hence, can be raised as alternative breeds in place of indigenous chickens (Murawska 2017; BFAP and SUA 2018). The productive performance in terms of growth, egg production and survival rate of

these breeds has been evaluated under different management conditions in Tanzania (Sanka et al. 2021a; Guni et al. 2021b). Sanka et al. (2021a) reported variations in carcass yield when Sasso and Kuroiler birds were subjected to varying levels of supplementations under simulated on-farm conditions. While Guni et al. (2021b) reported breed x location interaction for the body weight of the two breeds. However the information available on the carcass yield and egg quality traits of these breeds under varying management conditions is scant. This study intended first to compare carcass yield parameters for fully-fed Sasso and Kuroiler raised on station and secondly, establish if there are significant breed and management system effects on egg quality characteristics.

Materials And Methods

Location of the study area

Two studies were conducted for a period of 52 weeks from December 2018 to December 2019 using Kuroiler and Sasso chickens under on-station and on-farm conditions. The on-station study was conducted at Sokoine University of Agriculture (SUA). The University is located at the foothills of the Uluguru Mountains in Morogoro, Eastern Tanzania, about 550 m above sea level. The on-farm study was conducted in two villages i.e., Wami-Sokoine and Wami-Luhindo about 45 Km from the University.

Management of chicks during brooding

A total of 1200 (600 Kuroiler and 600 Sasso) day-old chicks were purchased from AKM Glitters in Dar es Salaam and Silverlands in Iringa regions respectively to be used in this study. Brooding was done for six weeks at the Poultry farm of the Sokoine University of Agriculture. On arrival these chicks were weighed, wing tagged and thereafter placed into the brooding pens. During the brooding period chicks were fed a commercial starter diet in form of crumbles containing 2941 Kcal ME/kg and 21.2% CP from day old up to the end of 2nd week and chick mash containing 3049 Kcal ME/kg and 20.3% CP from the 3rd up to end of the 6th week. Clean water was provided in ad-libitum. Chick sexing was done at the end of the brooding period.

Management of birds for egg quality evaluation under the on-farm condition

At the end of brooding, three hundred and twenty (320) growing pullets were distributed to selected farmers in the two villages. The selection of villages and households participating in the study was done in collaboration with District and Ward livestock officers. In each village, 16 farmers/households were recruited for the study. One half of the household in each village received 10 Sasso pullets each and the remaining eight households received 10 Kuroiler pullets. Allocation of the strains was done randomly. The pullets were reared under a semi-scavenging system of management. Each household was required to provide a house/shelter with a simple enclosure around the house which allowed restriction of birds especially during the provision of supplementary feeds. All along farmers were responsible for providing housing, supplementary feeding and basic health care. They were encouraged to make simple

formulations to include energy, some protein sources and mineral in addition to kitchen leftover and what they could get from scavenging.

Management of birds for egg quality and carcass characteristics evaluation under the on-station condition

Under the on-station experiment, a total of two hundred and forty (240) pullets were randomly allocated to 6 deep litter pens (3 for Kuroiler and 3 for Sasso) of 40 birds each and reared under total confinement. They were provided with a commercial grower ration containing 15.5% CP and 2762 Kcal ME/kg, from the 7th to the end of the 19th week of the age. Thereafter, layer rations containing 18.5% CP and 2965 Kcal ME/kg were provided from the 20th week of age up to the rest of the study period. Alongside, the cockerels were distributed using a 2 x 2 factorial design i.e. 2 breeds (Kuroiler and Sasso) and 2 slaughter ages (16 and 20 weeks), with six replications of 40 birds each (3 replications per each breed) making a total of 240 birds. The feeding system was similar to that of pullets up to the end of the 19th week of age.

Measurement of the external egg quality traits

A total of 666 fresh eggs (246 eggs from on-farm and 420 eggs from on-station) were used to evaluate the external egg quality traits. External egg quality traits such as egg weight, length, width, shape index, shell weight, shell thickness and shell ratio were determined. Egg weights were obtained by weighing individual eggs using a digital weigh balance whereas the length and width of the eggs were measured using a digital vernier calliper. Egg shape index (%) was calculated as the ratio of egg width to egg length times 100 (Anderson et al. 2004). The eggshells with their membranes were dried on open-air and weighed using a digital weighing balance. The shell weight was divided by egg weight to get the shell ratio. The thickness of shells was measured using a digital vernier calliper.

Measurement of the internal egg quality traits

The eggs used for external egg quality measurements were also used to measure the internal egg quality traits. The internal egg quality traits that were evaluated include yolk weight, albumen weight, yolk ratio, albumen ratio, albumen height and Haugh unit. The internal egg quality measurements were obtained by carefully breaking the egg followed by separation of the albumen and the yolk contents. The weight of albumen was obtained by taking total internal egg weight (i.e. yolk weight + albumen weight) minus yolk weight. The albumen weight and yolk weight were determined using a digital weighing balance, whereas albumen height was measured using a digital vernier calliper. Albumen and yolk ratios were calculated by taking their weights as the percentage of total egg weight. Haugh Unit (HU) was calculated according to Haugh (1937) by fitting the average albumen height and egg weight into the following equation: $HU = 100 \log (H + 7.57 - 1.7W^{0.37})$, where H = Albumen height and W = Egg weight.

Measurement of carcass and carcass parts

At the end of the 16th and 20th weeks of age, a sample of 20 male birds in each age category, i.e.10 birds/breed were randomly selected and slaughtered to determine carcass weight as well as carcass

parts weights. Sampled birds were fasted for 12 hours before slaughtered. The carcass weight was taken after de-feathering and removal of feet, head and the viscera (gizzard, heart, spleen, liver and intestine). The eviscerated carcass, breast, thighs, drumsticks, wings, back and neck were weighed using a digital balance. These data were used to calculate the dressing percentage and carcass part yields (%) by taking the weight of the individual parts as the percentage of the live weight of the chicken.

Statistical data analysis

The General Linear Models (GLM) procedure of SAS software (SAS 2009) was used to analyze all traits measured by considering management system and breed as fixed effects for egg quality traits, as well as the interaction between them. Breed and slaughter age was considered as the fixed effects for carcass traits under the on-station management. Individual farmer or pen effect within a management condition was taken as a random effect for egg quality traits while individual bird was taken as a random effect for carcass traits.

The following statistical model was used to analyze the external and internal egg quality traits observed on a pen or household basis (i.e. the pen or household was the observation unit):

$$Y_{ijklm} = \mu + M_i + B_j + (MB)_{ijk} + FP(MB)_{ijkl} + E_{ijklm} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:

Y_{ijk} = observation (Egg quality traits) from the kth farmer/pen within the jth breed and i^{th} management system;

μ = General mean common to all observations in the study;

M_i = Effect of the ith management system (i = on-station, on-farm);

B_j = Effect of the jth breed (j = Kuroiler, Sasso);

$(MB)_{ijk}$ = Effect associated with the interaction between management system and breed;

$FP(MB)_{ijkl}$ = Random effect of the kth farmer/pen within the jth breed and i^{th} management system;

E_{ijklm} = Random effects peculiar to each bird;

Note

Effects of the management system and breed for egg quality variables were tested using the farmer/pen variation within the management system and breed (i.e. $FP(MB)_{ijk}$) as the error term.

For Live weight, carcass and parts yield the following model was used.

$$Y_{ijk} = \mu + B_i + A_j + (BA)_{ij} + E_{ijk} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where:

Y_{ijk} = observation (Live weight, carcass and parts yield) from the ith breed within the jth age;

μ = General mean common to all observations in the study;

B_i = Effect of the ith breed (i = Kuroiler, Sasso);

A_j = Effect of the jth age (week), (j = 16, 20)

$(BA)_{ij}$ = Effect associated with the interaction between breed and age;

E_{ijk} = Random effect peculiar to each bird.

Results And Discussion

Effects of management system and breed on external and internal egg quality traits

Table 1 presents the least-square mean values for the effect of management system and breed on external and internal egg quality traits of chickens. Management system significantly (P < 0.05) affected almost all egg quality traits except shell ratio, yolk ratio and albumen ratio. On the other hand, egg weight, egg length, yolk weight, albumen height and Haugh unit were influenced (P < 0.05) by the breed of chickens.

Table 1
Least square mean values for the effect of management system and breed on external and internal egg quality traits of chickens.

Variable	Management system		Breed		SEM	P-value	
	On-farm	On-station	Kuroiler	Sasso		Management	Breed
External egg quality traits							
Egg weight (g)	53.20[b]	59.73[a]	57.13[a]	55.80[b]	0.32	< .0001	0.0365
Egg length (mm)	55.94[b]	57.05[a]	56.89[a]	56.10[b]	0.16	< .0001	0.0060
Egg-width (mm)	41.28[b]	43.00[a]	42.28[a]	41.99[a]	0.09	< .0001	0.1069
Egg Shape index (%)	73.92[b]	75.48[a]	74.73[a]	74.97[a]	0.25	< .0001	0.1062
Shell weight (g)	6.08[b]	6.94[a]	6.58[a]	6.44[a]	0.06	< .0001	0.1131
Shell ratio (%)	11.47[a]	11.67[a]	11.56[a]	11.59[a]	0.09	0.1499	0.9683
Shell thickness (mm)	0.53[b]	0.56[a]	0.55[a]	0.54[a]	0.00	0.0008	0.9921
Internal egg quality traits							
Yolk weight (g)	17.12[b]	19.47[a]	18.61[a]	17.98[b]	0.13	< .0001	0.0029
Yolk ratio (%)	32.30[a]	32.66[a]	32.62[a]	32.35[a]	0.22	0.3047	0.3481
Albumin weight(g)	29.89[b]	33.12[a]	31.87[a]	31.14[a]	0.26	< .0001	0.1456
Albumin ratio (%)	56.11[a]	55.39[a]	55.76[a]	55.74[a]	0.26	0.0892	0.9565
Albumin height (mm)	6.80[b]	7.58[a]	7.29[a]	7.09[b]	0.04	< .0001	0.0080
Haugh unit	84.12[b]	86.98[a]	85.98[a]	85.12[b]	0.24	< .0001	0.0243

a−b Means with different superscripts within a row and effect differed significantly (P < 0.05), SEM = Standard error of the mean

The observed difference between the two management systems on egg weight might be partly due to the rearing system but mostly due to insufficient feeding prevailing under on-farm that does not support the birds with adequate levels of nutrition needed to exploit their production potential. This observation concurs with the previous observation of Guni et al. (2021a) which also showed lower performance of on-farm than on-station management in most egg production traits. Similarly, Champati et al. (2020)

reported heavier eggs for intensively reared chickens than for semi-intensive while Dong et al. (2017) and Kucukyılmaz et al. (2012) also observed variation in egg weight for different rearing systems. In contrast to the present findings, Patel et al. (2018) and Sokołowicz et al. (2018) did not find significant differences in egg weight between deep litter and other rearing systems. Conflicting reports from these authors are likely due to the effect of a variety of factors, such as genotype, nutrition, and environment (Rakonjac et al. 2014).

Kuroiler chickens had heavier eggs than Sasso chickens which may have been attributed to the hen genotype. However, using similar breeds, Sanka et al. (2021b) did not find significant differences in egg weight. Such dissimilar observations between the present study and that of Sanka et al. (2021b) might be due to differences in the management of the birds, specifically on feeding practices. The overall egg weight (55.80g) for Sasso chickens in the present study is within the range 45.7–59.9g and 48.0–56g reported by Sanka et al. (2021b) and Kidie (2019) respectively for a similar breed. Likewise, the egg weight for Kuroiler in this study (57.13g) is within the range 46.25–57.65g and 47.0–59.0g reported by the same authors in the same order. In contrast, Bamidele et al. (2019) reported that the overall egg weight for Kuroiler and Sasso was 54.0 and 54.9g respectively, which was lower than the egg weight observed in the present study. This difference might be attributed to variation in feeding and other environmental factors affecting egg weight in chickens.

The shape of an egg is important during both, packaging and transportation by reducing possible breakage of eggs and it also plays part in determining market preference (Guni et al. 2013). The observed higher shape index for on-station eggs than those from on-farm could be explained by the size and weight of an egg. Normally egg length and width are the determinants of the shape of an egg, which were also higher for on-station eggs than on-farm. Sokołowicz et al. (2018) had a similar observation where the egg shape index was found to be higher for birds under deep litter than those from free-range and organic systems. Similarly, using Red Island Red (RIR) and Fayoumi Bekele et al. (2009), found a higher egg shape index for eggs from the on-station than from on-farm. On the other hand, insignificant effects of the rearing system on egg shape indices were reported by Sekeroglu et al. (2010), Oke et al. (2014), and Champati et al. (2020). The shape index in the present varied from 73.92–75.48%. This value falls within a value of 72–76% reported by Altuntas and Sekeroglu (2008) as the standard/normal shape. The obtained shape indices were similar to the result by Sanka et al. (2021b), but lower than values of 76.08 to 77.52% reported by Mengsite et al. (2019) for the Sasso strain. The eggs with a shape index below 72% are sharp and those above 76% are roundish (Altuntas and Sekeroglu 2008) which increase the possibility for breakages during transportation.

Eggshell quality is also associated with levels of resistance to breakages during transportation. In this study, the management system significantly (P < 0.05) affected shell weight and shell thickness in favour of on-station. The lower values for on-farm eggs for shell quality is most likely to be associated with poor feeding and inadequate Calcium and other trace minerals intake. Several authors have reported varying results on the effect of the management system on shell weight and shell thickness. For example, Ogunshola et al. (2018) reported heavier eggshell in the deep litter system than in the cage system but

observed no significant difference in shell thickness between these systems. On the other hand, Dahloum et al. (2018) did find differences in shell weight of eggs from different rearing systems. Kuhn et al. (2014) also did not find differences in shell weight and thickness of eggs from the litter-floor and free-range systems. Likewise, Patel et al. (2018) observed no differences in shell thickness of eggs from deep litter, semi-scavenging and backyard management. Inconsistent results might be associated with the interaction of the management system with several factors affecting these traits including genotype used, age, oviposition time, and mineral nutrition (Ketta and Tumova 2016).

Yolk weight and albumen weight differed (P < 0.05) between the two management systems with on-station eggs showing higher values than on-farm. In agreement with the results of the present study Sokolowicz et al. (2018) and Dong et al. (2017) also observed variation in rearing systems on yolk weight. The higher mean values for yolk weight and albumen weight from on-station eggs in this study might be related to the size of an egg as these traits have a significant association with egg weight (Suk and Park 2001). This observation conforms to the arguments put forward by Zhang et al. (2005) and Aygun and Yetisir (2010) that egg weight influences the weight of components of eggs especially albumen and yolk. Thus the heavier yolk weight observed for eggs from Kuroiler than Sasso might have been due to such a bigger size of Kuroiler eggs.

Yolk ratio and albumen ratio were neither affected by the management system nor by the breed. This may imply that the share of these traits to the total egg weight of the two breeds is similar regardless of breed or management system. In agreement, Sanka et al. (2021b) also observed a similarity in yolk and albumen ratio for Kuroiler and Sasso eggs under semi-scavenging management. Moreover, Patel et al. (2018) reported similar observation on the yolk ratio but they reported contrasting result on the albumen ratio. Dong et al. (2018) also found the insignificant effect of rearing systems on egg yolk ratio.

Albumen height and Haugh unit were affected by both, the management system and the breed. The superiority of albumen height and Haugh unit observed in eggs from on-station could be associated with appropriate storage and the fact that the eggs were analyzed on the day of collection. Bekele et al. (2009) observed a similar situation for on-farm and on-station trial in Ethiopia. In addition, Sokolowicz et al. (2018) also found a significant rearing system effect where eggs from the deep litter system outperformed free-range in Haugh unit. However, Dong et al. (2017) did not find any differences between rearing systems on these traits.

Differences in albumen height and Haugh unit were also observed between breeds whereby Kuroiler tended to have a higher score than Sasso birds. This observation is in agreement with that of Kucukyılmaz et al. (2012) where White (Lohmann LSL) outperformed Brown (ATAK-S) hens in these traits. However, the report of Sanka et al. (2021b) that eggs from Kuroiler and Sasso had similar values for the albumen and Haugh unit disagree with the result of the present study. This disagreement in results between this study and that of Sanka et al. (2021b) is likely due to the variation in feeding management prevailing in particular studies.

Effect of interaction between management system and breed on external and internal egg quality traits

Table 2 shows the interaction effect between management system and breed on external and internal egg quality traits. The results show that there was no significant ($P > 0.05$) interaction effects between the management system and breed for all egg quality traits except for egg weight and eggshell ratio. This implies that with exception of egg weight and shell ratio, the response of the two breeds on egg quality traits is similar regardless of the management system. Similar to the present findings, Bekele et al. (2009) and Kucukyılmaz et al. (2012) also found significant interaction effects on egg weight when two breeds were compared under two different rearing systems. In contrast, Sokolowicz et al. (2018) did not find significant interactions between the rearing system and breed on egg weight.

Table 2
Least square mean values for the interaction effect between management system and breed on external and internal egg quality traits of chickens

Variable	On-farm		On-station		SEM	P-value
	Kuroiler	Sasso	Kuroiler	Sasso		
External egg quality traits						
Egg weight (g)	53.51[c]	53.05[c]	60.74[a]	58.55[b]	0.42	0.0458
Egg length (mm)	56.25[bc]	55.72[c]	57.41[a]	56.60[b]	0.21	0.5179
Egg-width (mm)	41.34[c]	41.30[c]	43.24[a]	42.70[b]	0.12	0.0549
Egg Shape index (%)	73.57[bc]	74.27[c]	75.42[ab]	75.58[a]	0.31	0.3907
Shell weight (g)	6.19[b]	5.97[b]	6.96[a]	6.93[a]	0.06	0.1823
Shell ratio (%)	11.60[ab]	11.32[b]	11.49[b]	11.89[a]	0.11	0.0046
Shell thickness (mm)	0.54[b]	0.54[b]	0.56[a]	0.56[a]	0.00	0.9578
Internal egg quality traits						
Yolk weight (g)	17.35[c]	16.89[c]	19.65[a]	19.22[b]	0.16	0.9063
Yolk ratio (%)	32.43[ab]	32.08[b]	32.37[ab]	32.92[a]	0.27	0.1147
Albumin weight(g)	30.16[c]	29.74[c]	33.84[a]	32.33[b]	0.32	0.1059
Albumin ratio (%)	56.37[a]	55.92[ab]	55.66[ab]	55.16[b]	0.33	0.9546
Albumin height (mm)	6.85[c]	6.71[c]	7.64[a]	7.51[a]	0.05	0.9829
Haugh unit	84.39[b]	83.69[b]	87.05[a]	86.86[a]	0.31	0.4028

[a–c] Means with different superscripts within a row differed significantly (P < 0.05), SEM = Standard error of the mean

Effect of slaughter age and breed on carcass characteristics of chickens

Table 3 shows the least-square mean values for the effects of slaughter age and breed on carcass characteristics of chickens. The slaughter weight, carcass weight and all carcass parts weight differed significantly (P < 0.05) between ages of slaughter. Birds slaughtered at 20 weeks of age presented heavier carcass weight and higher carcass parts than those slaughtered at 16 weeks of age. This observation may imply that the carcass parts of the two breeds increased in weight concurrently as the slaughter age increases. This observation is in line with the report of several authors (Albuquerque et al. 2003; Horsted

et al. 2005; Nikolova and Pavlovski 2009; Ojedapo et al. 2015). Similarly, slaughter age had also significant effects on dressing percentage as well as drumstick, back and wing percentages. It was observed that while the dressing percentage and the proportions of drumstick, back and wing were increasing with the age of slaughter, the proportion of wing weight decreased. The increase in proportions of other parts such as drumstick likely led to a decrease in wing proportion.

Table 3

Least square mean values for the effects of slaughter age and breed on live weight (g), slaughter weight (g), carcass weight and carcass parts in gram and percentages.

Variable	Slaughter age (week)		Breed		SEM	P-value	
	16	20	Kuroiler	Sasso		Slaughter age	Breed
Live weight (g)	2169.30[b]	2656.80[a]	2261.90[b]	2564.20[a]	51.16	< .0001	0.0002
Slaughter weight (g)	2106.25[b]	2559.30[a]	2186.70[b]	2478.80[a]	50.55	< .0001	0.0002
Carcass weight (g)	1484.55[b]	1883.65[a]	1552.05[b]	1816.15[a]	38.18	< .0001	< .0001
Breast weight (g)	377.05[b]	483.70[a]	380.35[b]	480.40[a]	13.13	< .0001	< .0001
Thigh weight (g)	259.80[b]	322.70[a]	271.45[b]	311.05[a]	7.52	< .0001	0.0007
Drumstick weight (g)	236.95[b]	303.75[a]	255.95[b]	284.75[a]	6.34	< .0001	0.0028
Back weight (g)	296.30[b]	392.20[a]	312.80[b]	375.70[a]	9.03	< .0001	< .0001
Wing weight (g)	200.15[b]	234.20[a]	205.70[b]	228.65[a]	4.49	< .0001	0.0009
Neck weight (g)	101.65[b]	130.20[a]	105.65[b]	126.20[a]	3.31	< .0001	< .0001
Dressing %	68.38[b]	70.79[a]	68.54[b]	70.63[a]	0.49	0.0015	0.0052
Breast (%)	17.31[a]	18.34[a]	16.83[b]	18.63[a]	0.35	0.1040	0.0009
Thigh (%)	12.00	12.12	12.03	12.09	0.18	0.6538	0.8163
Drumstick (%)	10.94[b]	11.44[a]	11.32	11.06	0.13	0.0119	0.1756
Back (%)	13.60[b]	14.74[a]	13.74[b]	14.60[a]	0.21	0.0005	0.0064
Wing (%)	9.27[a]	8.82[b]	9.17[a]	8.93[a]	0.13	0.0220	0.2152
Neck (%)	4.66[a]	4.90[a]	4.64[b]	4.91[a]	0.08	0.0634	0.0355

[a-b] Means with different superscripts within a row and effect differed significantly (P < 0.05), SEM = Standard error of the mean

The present study also shows that there were significant (P < 0.05) differences between the two breeds on live weight, slaughter weight and all carcass traits studied except for thigh, drumstick and wing

percentages. The slaughter weight, carcass weight and carcass parts weight were found to be higher for Sasso chickens than for Kuroiler chickens. This observation indicates variation in the genetic potential of the two breeds in growth rate and muscle deposition. The higher carcass weight of Sasso than Kuroiler was expected due to a heavier bodyweight of the former at slaughter. This observation concurs with the report of Rezaei et al. (2018) and several authors who indicated higher carcass weight for heavier birds. Unlike the present observation, Sanka et al. (2021a) reported the absence of significant differences between Kuroiler and Sasso chickens on carcass traits when birds were reared under a simulated scavenging system with varying levels of supplementations. Contrasting results between the present study and that of Sanka et al. (2021a) might be due to differences in the rearing system, and in particular feeding management and the ability of the breed to respond to that particular management. For example, in a previous study on the effect of management systems by Guni et al. (2021a), results showed a better performance for Sasso than Kuroiler under the on-station while under the on-farm the performance was similar. The overall mean of the carcass weight for Kuroiler chickens observed in the present study is higher than 1400.6g for Koekoek chickens reported by Ibrahim et al. (2019) but comparable to (1585g) and (1552g) for Hubbard S757 and Lohman dual genotypes respectively, reported by Muller et al. (2018).

Breast meat yield is the carcass component with the highest economic value followed by legs (thigh + drumstick). These parts are considered the most valuable parts in broiler and dual-purpose male chickens kept for meat production, while the back, wing and neck are less valuable parts (Biazen et al. 2021). The higher breast weight relative to other carcass parts might be related effect of selection for meat production where more attention is placed on the breast proportion (Marapana 2016). Though the breeds used are not pure meat birds, by being dual-purpose birds, they thus carry genes from meat breeds.

The difference between breeds in terms of carcass parts is directly related to the slaughter weight, whereby Sasso gave higher proportions than Kuroiler. It has been reported by Olawumi (2013) that the slaughter weight has significant positive correlation with breast weight (r = 0.89), thigh weight (r = 0.95), back weight (r = 0.96) and drumstick weight (r = 0.92) in broiler chickens. Additionally, Katekhaye (2017) and Biazen et al. (2021) reported higher breast, wing, neck and back weight in chickens with heavier slaughter weight. The two breeds also differed (P < 0.05) in dressing percentage as well as the proportions of breast, back and neck in favour of Sasso, while the proportions of the thigh, drumstick and wing were similar between the two breeds.. This observation is in agreement with that Lichovníkova et al. (2009) who also reported similar proportions of leg muscle (thigh and drumstick) when fast-growing chickens were compared to layer male chickens. However, the dressing percentages observed in this study for both Kuroiler (68.54%) and Sasso (70.63%) are higher than (66.75%) for Kuroiler chickens reported by Aline (2015) in Uganda. The difference in dressing percentage and the proportions of various parts between this study and of the other authors might be due to differences in the breed and the rearing system. According to Marapana (2016), the dressing percentage and relative meat yield in the different parts could be affected by several factors such as strain, sex, length of feed withdrawal before processing, length of starvation before slaughtering, the birds' transport distance from farm to slaughter plant, the life span of birds and the birds rearing system.

Effect of interaction between breed and slaughter age on carcass traits

The least-square means for the interaction between breed and slaughter age on carcass traits are presented in Table 4. Only the percentage of thigh and neck showed significant (P < 0.05) interaction between breed and age of slaughter. It was observed that, while Kuroiler had a higher thigh percentage than Sasso at the 16th week of slaughter age, the reverse was the case at 20 weeks of slaughter age.

Table 4
Least square mean values for the interaction effect between slaughter age and breed on live weight (g), slaughter weight (g), carcass weight and carcass parts in gram and percentages.

Variable	Age (week 16)		Age (week 20)		SEM	P-value
	Kuroiler	Sasso	Kuroiler	Sasso		
Live weight (g)	2000.80[c]	2340.80[b]	2526.00[b]	2787.60[a]	72.36	0.5773
Slaughter weight (g)	1939.30[c]	2273.20[b]	2434.10[b]	2684.50[a]	71.50	0.5629
Carcass weight (g)	1346.60[c]	1622.50[b]	1757.50[b]	2009.80[a]	53.97	0.8282
Breast weight (g)	335.10[c]	419.00[b]	425.60[b]	541.80[a]	18.57	0.3903
Thigh weight (g)	247.70[c]	271.90[b]	295.20[b]	350.20[a]	10.63	0.1564
Drumstick weight (g)	221.40[d]	252.50[c]	290.50[b]	317.00[a]	8.97	0.7993
Back weight (g)	257.20[c]	335.40[b]	368.40[b]	416.00[a]	12.77	0.2388
Wing weight (g)	188.00[c]	212.30[b]	223.40[b]	245.00[a]	6.35	0.8331
Neck weight (g)	87.60 [c]	115.70[b]	123.70[b]	136.70[a]	4.68	0.1160
Dressing %	67.56[c]	69.20[b]	69.53[b]	72.06[a]	0.70	0.5219
Breast %	16.77[b]	17.86[b]	16.89[b]	19.39[a]	0.49	0.1619
Thigh %	12.38[ab]	11.63[c]	11.68[bc]	12.56[a]	0.25	0.0029
Drumstick %	11.12[ab]	10.75[b]	11.51[a]	11.36[a]	0.18	0.5700
Back %	12.92[b]	14.28[a]	14.56[a]	14.92[a]	0.29	0.1017
Wing %	9.48[a]	9.06[ab]	8.85[b]	8.79[b]	0.18	0.3461
Neck %	4.38[b]	4.93[a]	4.89[a]	4.90[a]	0.12	0.0423

[a–d] Means with different superscripts within a row differed significantly (P < 0.05), SEM = Standard error of the mean

Conclusion

Based on the results of the present study, it is concluded that both the external and internal quality of eggs were influenced by the management condition. Eggs from on-station appeared to be better in quality than those of on-farm. Breed influenced some egg quality traits and most of the carcass traits. Sasso outperformed Kuroilers in carcass weight and the weight of its parts, whereas Kuroiler had heavier eggs with a higher Haugh unit score than Sasso.

Declarations

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