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Original Research

Evaluation of Egg Quality and Carcass Characteristics of Different Strains of Chickens Produced under Varied Management Systems in Western Oromia, Ethiopia

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Abstract

The study was undertaken to Evaluate egg quality of Local Horro chickens produced under different agro-ecologies and carcass characteristics of three chicken breeds namely, (Improved Horro (IH), Potchefstroom Koekoek (PK), white feathered DZ (DZ1) produced under the same management. For the carcass characteristics determination among the three chicken breeds, 30 male chickens; 10 for each breed (IH, PK and DZ1) were slaughtered. For egg quality evaluation and carcass characteristics analysis, crosstab and GLM in SPSS ver. 20 was employed. The egg weight, egg length, egg width, shell weight and shell thicknesses had significant (P <0.001) differences across the three agroecologies (highland, midland and lowland). Agroecology also significantly (P<0.01) affected all external egg quality traits studied except egg shape index. The mean internal egg quality traits (albumen weight, yolk weight, yolk-albumen ratio and yolk diameter) were significantly (P<0.001) affected by agro-ecology. For the carcass characteristics determination, the live weight of chicken breed had a significant (P<0.01) difference whereas carcass weight and the cuts, such as hot carcass weight (HCW), chilled carcass weight (CCW), breast yield, and drumstick weight had no significant (P>0.05) difference. However, the thigh weight among the cuts evaluated had a slight significant (P<0.01) difference. Overall agro-ecologic and chicken breed variations with respect to productivity and product quality showed the effects of agro-ecologic differences, chicken strains and management on performances of chicken.

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INTRODUCTION

In recent years, an emerging middle-class urban society and urbanization with better income and more purchasing power has increased the demand for chicken and chicken products. Over the last decades, the consumption of poultry products in developing countries therefore grew by 5.8 percent per annum, faster than the human population growth (Sonaiya *et al.,* 2004). Chicken accessibility and availability mainly in rural areas not only plays roles in poverty alleviation (Pica-Ciamarra and Dhawan, 2009) but also their consumption is associated with less health risk diseases (Wattanachant *et al*., 2004). This has led to the expansion of poultry production particularly within urban and peri-urban areas. Thus, production and productivity of village chicken should be improved through the type of chicken breed used, management and husbandry practices applied.

Poultry meat consumption has changed from whole bird to cut-up or further processing modes. Earlier it was sufficient to measure performances using body weights. Experiments now often include commercial parts analyses or body chemical composition, or both. Commercial parts always include the portion of breast meat, often without skin. This is because of the usually greater value of breast for cut-up or in further processing. Other commonly reported parts include thighs, drumsticks, and wings. The pH of muscle tissue is extremely important to meat science since the pH at specific times during the conversion of muscle to meat, as well as the ultimate pH of meat, affects many quality factors. The pH value of the chicken meat is also regarded as paramount importance to meat quality as it influences the structure of myofibrils and in turn the colour of the meat (Dyubele *et al.,* 2010). Evaluation of the egg production performance of crossbreeds between local and exotic birds was conducted by different research and

development organizations (Haile-Mariam, 1998; Melesse *et al.,* 2005). However, no comparative study among the Horro, the Potchefstroom Koekoek and the synthetic White feather Debrezeyit (DZ1) chicken on productive performance the newly invented DZ1 and Improved Horro. The present study was aimed to evaluate egg quality characteristics of local Horro chickens (indigenous chicken breed in Ethiopia) produced under varied agro-ecologies and carcass characteristics of the three chicken breeds produced under same management.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in the Horro Guduru, East Wollega and West Shewa zones. The area is situated at about 250-330km West of Addis Ababa. The Horro, Bako and Nekemte areas were selected to represent the highland, lowland and Midland agro-ecologies respectively. While the egg quality of local Horro chicken was determined across the agro ecologies, a comparative study of carcass characteristics of Improved Horro, DZ White-feathered chicken and Potchefstroom Koekoek was employed on-station in Nekemte city.

Description of Study Animals

Three improved chicken breed reared on-station management namely [Improved Horro (IH), Potchefstroom Koekoek (PK), DZ White-feathered chicken (DZ1)] and unimproved Horro chicken ecotype produced under village production system were used for the study.

Improved Horro (IH) chicken breed

The Horro chicken ecotype is one of Ethiopian indigenous chicken ecotypes such as; Tilili, Jarso, Tepi, Gelila, Debre-Elias, Melo-Hamusit, Gassay/Farta, Guangua and Mecha which were named after their geographic region of origin (Halima, 2007). This chicken ecotype is named after the particular area called Horro district found in Northwestern Ethiopia. Nowadays, this chicken ecotype has been distributed to a wider area in Ethiopia in particular through research institutions and Universities. Earlier, there were about 30,000 chickens restricted to this original environment (Dana *et al.,* 2010)

Potchefstroom Koekoek (PK) Chicken breed

The second chicken breed used for the present study was the Potchefstroom Koekoek (PK). The Potchefstroom Koekoek chicken are a composite of the White Leghorn, Black Australorp and Bared Plymouth Rock exotic chickens bred at the Potchefstroom Agricultural College, in South Africa during the 1950s (Grobbelaar, 2010). The PK was selected based on good advantages as seen in Debre Zeit National Agricultural Research Center (DZARC) farm, with 200 eggs per hen per year, 55.5g egg weight, deep yellow skin, relatively high body weight (BW) of male (2.65kg) and female (1.87kg) at the end of production, and it carries sex-linked gene for color sexing of Day old chick (DOC) (Grobbelaar *et al* 2010; Wondmeneh *et al.,* 2011).

The DZ White-feathered (DZ1) chicken

The DZ1 is a white colored chicken breed, is a synthetic breed produced at the DZARC through selective crossbreeding. This breed of chicken was produced with a combination of Lohnmann Silver, Potchefstroom Koekoek, and local White colored chicken ecotype of Ethiopia. These synthetic DZ White-feathered chickens used for the current study were at their 9th generation of establishment.

Egg Quality and Carcass Characteristics

For external and internal egg quality determination, 150 eggs of local Horro chickens was collected from three agroecologies that 50 chickens' eggs from each agroecology (highland, Midland and lowland) reared under traditional management were bought. External egg quality traits such as egg weight, length, width, shape index, surface area, shell weight, shell thickness and shell ratio were determined. The individual eggs were weighed with a digital sensitive balance to the nearest of 0.01gm accuracy. The eggs' length and breadth were measured with the help of digital calipers and shape index was calculated as the ratio of breadth to length times 100 and surface area (S) was calculated with a formula of $S=4\pi r^2$. Radius (r) was calculated as ¼ (length + breadth) of the egg according to Rath *et al.* (2015).

For internal egg quality determination, the width of the yolk was measured in 'millimeters' with the help of a vernier caliper. Albumen height was measured using a micrometer at 3 or 4 locations and averaged. Haugh unit (H.U.) was also calculated by using the formula $HU = 100 \log(H+7.57-1.7W^{0.37})$ where H is albumen height in millimeters, measured by micrometer and W is the observed weight of the egg in grams (Haugh, 1937, and Oluyemi and Roberts, 1979). Albumen weight was calculated as egg weight- (Yolk weight + shell weight). Albumen and yolk ratios were calculated taking their individual weights as the percentage of total egg weight. The yolk diameter was estimated as the average of yolk length and breadth. Yolk to albumen ratio was calculated as the weight of yolk/weight of albumen.

The Haugh Unit values was calculated using the formula $HU= 100 \log(H + 7.57\text{-}1.7W^{0.37})$ as;

HU = Haugh Unit; H = Observed height of the albumen (mm) and W= Weight of the eggs in grams.

Some of the egg quality traits were estimated using the following mathematical formulas:

Shape index (%) = (Width of egg / Length of egg) × 100

Albumen (%) = (Albumen weight / Egg weight) × 100

Yolk (%) = (Yolk weight / Egg weight) × 100

Shell weight = Egg weight – (Albumen weight + Yolk weight)

Shell (%) = (Shell weight / Egg weight) × 100

Carcass characteristics determination

For on-station carcass characteristics determination and comparison among chicken breeds, 30 male chickens or 10 chickens from each breed (the Improved Horro, Koekoek and DZ White-feathered) were slaughtered for carcass characteristics determination. All the cocks slaughtered were eight months aged. The chickens were randomly selected, weighed and fasted for 12hrs with free access to drinking water. Thereafter, the chickens were slaughtered by cervical dislocation. Carcass weight, breast meat, thigh and drumstick and edible offal; gizzard, Heart and liver were measured using a digital weighing scale.

For calculation of chilled carcass weight (CCW), the carcasses from other replicates were stored at 4ºC for 24 and 48hrs. The dressing percentage was calculated as the proportion of carcass weight to live weight of each bird according to Teketel (1986) and Motsepe *et al.* (2016). The post-slaughter pH was also determined on the breast, drumstick and thigh muscle of each bird using a digital pH meter at time intervals of 30 min, 24 and 48hrs post-slaughter. The slaughtering was performed in the laboratory of Wollega University by one skilled person in order that technical biases would be avoided. For egg quality evaluation and carcass characteristics analysis, crosstab and GLM in SPSS ver. 20 was employed.

Statistical Models Set

Effect of chicken genotype on carcass characteristics;

$Y_{ik} = \mu + G_i + Aj + (GA)ij + e_{ik}$

Where, Y_{ik} = external and internal egg quality traits

μ = Overall mean

G_i = effect of i^{th} chicken genotype, i=3 (Koekoek, DZ white feathered, Improved Horro)

Aj = effect of time of meat aging, j= 3 (0.5hrs, 24hrs and 48hrs meat aging after slaughter)

(GA)ij = interaction of fixed effect of chicken genotype and meat aging

e_{ijk}= random error normally and independently distributed

RESULTS

Egg Quality and Carcass Characteristics Determination

Table 1, below presents the result of the external egg quality traits. The study revealed that there were highly significant (*P*<0.001) variations among the external egg quality traits studied across the three agroecologies. The result in Table 1 revealed that there were higher external egg quality traits such as egg weight (43.55gm), egg length (52.73 mm), egg width (37.06 mm) and egg surface area (504.00 mm^2) for the midland agroecology The egg weight, egg length, egg width, shell weight and shell thicknesses in general showed highly significant (P<0.05) differences excluding the shape index, which showed non-significant (*P*>0.05) variation. Agro-ecology significantly (*P*<0.01) affected all external egg quality traits studied except the egg shape index. Shape index which is the ratio of width to length of egg ranged from 70.37% at the mid-altitude to 71.61% at the highland agro-ecology.

The mean egg weight, egg length, egg width and egg surface area (504 mm^2) of the mid-altitude of Horro chickens' eggs produced under traditional management was the highest followed by the lowland Horro chickens' surface area (487.08 mm^2); where a relatively lowest surface area (473.93 mm^2) was recorded for highland chickens' eggs. The highest mean shell weight, shell thickness and shell ratio 4.91g, 0.37 mm and 11.73 respectively, were recorded for the lowland Horro chickens' egg compared to the chickens' egg shell weight, thickness and a shell to egg ratio of the highland and those of the mid-altitude. The egg of the lowland Horro chicken had thicker shell than the egg shell of the egg at the other two agro-ecologies.

Table 1. A Mean external egg quality traits of unimproved Horro chicken ecotypes under different agro-ecologies

Variables studied	Agro-Ecology				F Value	P Value
	Highland	Mid Altitude	Lowland	Grand mean		
Egg weight(gm)	37.38±0.64	43.55±0.66	42.60±0.79	41.18±0.41	25.347	0.000
Shell weight(gm)	3.61±0.13	4.49±0.14	4.91±0.16	4.34±0.08	21.810	0.000
Egg length (mm)	50.76±0.34	52.73±0.34	51.8±0.38	51.76±0.21	2.811	0.000
Egg width(mm)	36.31±0.23	37.06±0.23	36.84±0.25	36.74±0.14	8.123	0.000
Shape Index (%)	71.61	70.37	71.20	71.06	1.773	0.174
Shell thickness (mm)	0.35±0.06	0.36±0.06	0.37±0.07	0.36±0.04	13.911	0.000
Surface area(mm^2)	473.93	504.00	487.08	488.34		
Shell ratio (%)	9.63	10.3	11.73	10.55		

Internal egg quality characteristics of unimproved Horro chicken ecotypes produced under traditional managements are presented in Table 2. According to the present study, higher internal egg quality trats for Albumen weight, Yolk weight, Yolk diameter and yolk ratio 22.62 gm, 16.02 gm, 41.1 mm and 36.76, respectively at the mid-altitude. The mean internal egg quality traits (albumen weight, yolk weight, yolk-albumen ratio and yolk diameter) in general were significantly (*P*<0.001) affected by agro-ecology. However, albumen height did not show a significant difference among the three agro-ecologies. Higher yolk weight, a yolk to albumen ratio and yolk diameters were recorded at the mid-altitude among the eggs of the three agro-ecologies and the lowest measures were reported at the highland. As opposed to other parameters studied, the Hough Unit (HU) and mean albumen height were the highest at the highland; where the mid-altitude and lowland chickens' egg HU follows in that order; however, the numerical variation among the records for mid-altitude and lowland eggs' HU was small.

Table 2. A Mean internal egg quality traits of unimproved Horro chicken ecotypes under different agro-ecologies

Variables studied	Agro-Ecology				F Value	P Value
	Highland	Mid- Altitude	Lowland	Grand mean		
Albumen wt(gm)	20.99±0.40	22.62±0.41	23.30±0.49	22.30±0.25	7.536	0.001
Yolk weight(gm)	12.56±0.34	16.02±0.35	14.36±0.41	14.32±0.21	25.750	0.000
Yolk-Albumen ratio (%)	61.15±1.83	71.14±1.89	61.96±2.25	64.75±1.15	8.439	0.000
Albumen height(mm)	4.65±0.11	4.43±0.11	4.35±0.12	4.48±0.07	1.830	0.164
Yolk diameter(mm)	36.6±0.5	41.1±0.5	39.7±0.5	39.1±0.28	23.536	0.000
Albumen ratio (%)	56.15	51.9	56.08	54.71		
Yolk ratio (%)	33.6	36.76	36.66	34.99		
Hough Unit (HU)	0.76	0.71	0.71	0.73		

- *Carcass characteristics of Improved Horro chicken in comparison to the Koekoek and DZ White-feathered chickens*

Carcass characteristics of the Potchefstroom koekoek, DZ White-feathered and Improved Horro chicken breeds are presented in Table 3. The live weight of chicken breeds had significant (*P*<0.01) differences that the largest live weight (1922.8gm) and the lowest (1514.8gm) was recorded for the improved Horro chicken. Concerning other carcass

weights and cuts such as; HCW, CCW, breast yield, and drumstick there was no significant difference. However, the thigh weight among the cuts evaluated had a slightly significant (P<0.05) difference. Higher dressing percentage and breast meat (*Pectoralis major plus minor*) were recorded for Improved Horro when compared with the Potchefstroom koekoek and DZ White-feathered chickens as opposed to the lower thigh and drumstick weight though the difference was non-significant. Among the edible offal; the gizzard, liver and heart of chickens were evaluated and the gizzard weight was significantly (P < 0.01) higher for the DZ White-feathered chicken breeds (58.8 gm) preceded by the Koekoek (52.2 gm) and that improved Horro was the lowest (29.4 gm), whereas the heart and liver had non-significant differences in mean weight. A higher dressing percentage (62.63) was recorded for improved Horro chicken which was higher than the dressing percentage 57.38 and 56.47 identified for the *Potchefstroom koekoek* and DZ White-feathered chicken breeds, respectively.

Table 3. Genotype-related differences in carcass characteristics of three chicken breeds of the same age and management system

	Breed of chicken				
Carcass traits	PK	DZ1	IH	**SE**	**P value**
Live weight in gm	1867.80	1922.80	1514.80	69.74	0.003
Hot carcass weight in gm	1076.20	1085.40	951.20	58.63	0.236
Dressing %	57.38	56.47	62.63	??	??
Chilled carcass weight in gm	1072.98	1065.09	940.66	61.48	0.271
Breast yield in gm	192.40	194.0	206.0	12.35	0.704
Thigh weight in gm	236.00	231.20	200.0	13.15	0.044
Drumstick weight in gm	201.60	189.60	159.60	10.71	0.152
Gizzard weight in gm	52.20	58.80	29.40	5.16	0.004
Heart weight in gm	8.60	8.40	6.80	0.92	0.237
Liver weight in gm	34.60	34.00	28.20	2.77	0.352

SE: Standard error; PK: Potchefstroom Koekoek, DZ1: DZ White-feathered and IH: Improved Horro chicken breeds

Table 4, presented the correlation among the live-weight, carcass yield, major chicken cuts and the edible offal of the Potchefstroom Koekoek, DZ White-feathered and Improved Horro chickens. The live weight of chickens had a highly significant (P<0.01) association with the HCW, CCW, Thigh muscle, Drumstick and Gizzard of chicken where Gizzard had negative association with the Breast yield, heart and liver weight of chicken. The highest association observed in the present study was recorded among the hot carcass weight and chilled carcass weight of the chickens under the study. Improved Horro chickens whose thighs and drumsticks were lower in weight when compared with the thighs and drumsticks of the Koekoek and DZ White-feathered chickens had a more developed breast muscle and less weighing gizzard

Table 4. Association among the live weight, carcass yield and edible offal of chicken breeds

	LW	HCW	CCW	Thigh wt	Drumstick	Breast yield	Gizzard	Liver	Heart
Live weight in gm	1	.							
Hot carcass weight	0.875**	1							
Chilled carcass wt	0.854**	0.996**	1						
Thigh weight	0.815**	0.919**	0.925**	1					
Drumstick weight	0.894**	0.890**	0.892**	0.823**	1				
Breast yield in gm	0.326	0.701**	0.707**	0.608*	0.457	1			
Gizzard weight	0.719**	0.377	0.352	0.345	0.500	-0.150	1		
Liver weight	0.530*	0.360	0.327	0.217	0.332	0.107	0.686**	1	
Heart weight	0.597*	0.706**	0.709**	0.788**	0.650**	0.402	-0.006	-0.226	1

LW= live weight; HCW= hot carcass weight; CCW= chilled carcass weight

The mean effects of breed of chicken and meat aging for the 30min, 24hrs and 48hrs after slaughter on pH of meat is presented in Table 5. The differences among the three breeds of chicken had not significant (P>0.05) on pH of thigh, drumstick and breast muscles of chicken, though slight numerical difference was observed in pH among both meat cuts and time of meat aging. For the figurative differences observed, more variation in meat pH was recorded for animal genotype where less variation was documented for the pH in interaction of breed to time of meat aging. Slightly higher mean pH (5.64±0.052) and (5.62±0.063) was recorded for the thigh and breast meat of Improved Horro chickens, respectively, where the thigh, drumstick, and breast meats of the Koekoek and DZ White-feathered chickens had a more or less similar pH measures.

Table 5. Effects of chicken breed and time of meat aging on post slaughter chicken meat pH

Variables		pH measure of cuts of carcass tested		
		Thigh	Drum stick	Breast
Breed of chicken	PK	5.59	5.61	5.51
	DZ1	5.57	5.60	5.50
	IH	5.64	5.54	5.62
	SE	0.052	0.065	0.063
Time of meat aging (hrs)	0.5	5.64	5.58	5.59
	24	5.55	5.61	5.61
	48	5.61	5.56	5.45
	SE	0.052	0.065	0.063
Probability				
Breed of chicken		0.443	0.842	0.160
Time of meat aging		0.591	0.699	0.369
Breed * time of aging		0.879	0.877	0.344

SE: Standard error PK: Potchefstroom koekoek, DZ1: DZ White-feathered, IH: Improved Horro

DISCUSSION

Carcass Characteristics and Egg Quality Evaluation

The dramatic changes in the market forms for poultry in recent years, from a predominantly whole bird commodity to modern highly diversified industry focused on cut up, deboned meat, and ready-to-eat further processed products that resulted in a change of quality expectation. Apart from the quantities of meat that must be produced, the quality of the products must be maintained in order to satisfy the demand under quality and health conditions. In the present study therefore, thirty male Improved Horro, Potchefstroom Koekoek and DZ White-feathered chickens; ten cocks of the same age level from each breed were slaughtered to determine the carcass characteristics of chicken breeds under the study and to compare the meat yield of Improved Horro chicken with the exotic Potchefstroom Koekoek and DZ White-feathered chickens produced under the same management.

The mean live-weight and the gizzard weight (one of the edible offal evaluated) were significantly (P<0.01) higher for the Koekoek and DZ White-feathered chickens amongst the three chicken breeds. However, the variation in hot carcass weight, chilled carcass weight, thigh weight, drumstick and breast yield though had variation, the difference was not statistically significant (P>0.05). As opposed to the report by Halima (2007) who documented that the carcass weight of local chickens at maturity in Ethiopia varies from 1045 to 1292 gm for male and from 642 to 874 gm for females, the mean hot carcass weight of male Improved Horro chicken in the current study was 951.20 gm.

The negative correlation between the breast weight and gizzard might be because of a well-developed breast muscle of the Improved Horro chickens' carcass when compared with breast yield of the remaining two breeds under the study as opposed to the lighter gizzard they hold when compared with a heavier gizzard of the Koekoek and DZ White-feathered chickens. Breed of chicken therefore, affect the weight of gizzard in agreement with the report by Hermiz *et al*. (2016) in Iraq who documented gizzard was not different in Ross and in cob, while Hubbard strain estimates were significantly (P≤0.05) different from both strains. Higher dressing percentage (62.63%) was recorded for Improved Horro chicken when compared with the lower dressing percentage 57.38 and 56.47% of the Koekoek and DZ White-feathered respectively, in contrast to higher percentage (67.6 and 65.3%) reported for Ovambo and Potchefstroom Koekoek, respectively by Motsepe *et al.* (2016) in South Africa. Higher dressing percentage of Improved Horro chicken in addition to the smaller gizzard size and lower weight of Horro chicken might have resulted in a non-significant difference in carcass weight among the three chicken breeds and the cuts is in accordance with the report by Teketel (1986) who found higher dressing percentage in indigenous chickens raised under station conditions compared with White Leghorns.

The non-significant differences in hot carcass weight (HCW), chilled carcass weight (CCW), thigh weight, drumstic and breast yield among the three breeds of chicken on the present study is in accordance with the report by Motsepe *et al.* (2016) in South Africa, who documented the values for LW, HCW, CCW, dressing percentage, breast and thigh weight of Ovambo and Potchefstroom Koekoek breeds did not differ significantly between them. This report also agrees with the report by Chen *et al.* (1993) who examined and reported the mass and slaughter yields of genotype had no significant influence on the examined properties, as opposed to sex and age. The other quality-determining factor examined under the present study was the pH (a measure how acidic or basic a solution is).

The pH of chicken cuts among the three breeds of chicken and meat storage time were not significantly different as opposed to the report by Ristic and Damme (2010) the pH value of meat is influenced by various factors such as genetics – breed, lines, gender of producers, the manner of holding animals, transport, lairage conditions and time - pre-slaughter stress, method of slaughter, technological parameters and post-mortem handling, storage time of meat, etc. Slightly higher pH of meat cuts of Improved Horro chicken meat and a slightly higher pH of chicken meat pH during the 24hrs post slaughter recorded in the present study agrees with the report by Motsepe *et al.* (2016) who documented the same result for Ovambo and Potchefstroom Koekoek, the South African indigenous chicken breeds.

Various egg quality traits were considered in the current study, on the external and internal local chickens' egg quality characteristics while comparing the effects of breed of chicken and agro-ecology on egg quality characteristics. The mean egg weight, egg length, and egg width had high differences (P<0.001) among the Potchefstroom Koekoek, DZ White-feathered, Improved Horro and local Horro chicken breeds in agreement with the report by Rajkumar *et al.,* (2009) who documented Naked neck chickens laid heavier eggs with higher mean length and width than the White Leghorn strain at 40 weeks of age. Egg weight variations in different genetic groups were reported by many authors (Washburn 1990; Padhi *et al.,* 1998; Chatterjee *et al.,* 2007). The egg shape indices of the Koekoek (72.7%), DZ White-feathered 73.5%) and Improved Horro chickens (73.9%) are in between the normal and standard range of egg shape index 72-76% reported by Altuntas and Sekeroglu (2008).

For local Horro chickens produced under traditional management, the overall mean egg weight of local Horro chicken produced under village management system was in the range between 37.38g at the highland agro ecology to a 43.55g at the mid-altitude. The result agrees with the report by Brannang and Persson (1990) and Asuquo *et al* (1993) who documented 38.0 gm average egg weight of local hens around Arsi, and the mean egg weight 41.65 gm reported by Wondimeneh *et al.* (2011) for the local Horro chickens' egg under improvement at Debre Zeit Agricultural Research Center in Ethiopia, and 40.0 gm light ecotype's egg weight in Nigeria. However, the mean egg weight reported in the

current study is lower than the 46.0 gm mean egg weight reported by Teketel (1986) for local chicken in Ethiopia. The higher egg weight (43.55 gm) recorded for the mid altitude in the present study in comparison to that of the low and highland might be due the moderate agro-ecology and higher involvement of midland dwellers on crop production that more poultry feed is available.

The overall mean egg length (51.76 mm) recorded for the local Horro chicken in the present study is smaller than the egg length (53.6) reported by Asuquo *et al.* (1992) for light ecotypes in Nigeria. The difference in the rate of egg shape index amongst chicken breeds was not large that 72.7, 73.5, 73.9 and 70.9% were recorded for the Koekoek, DZ White-feathered, improved Horro and local Horro chickens' respectively, though the highest rate (numerical) was recorded for improved Horro and the lowest for the local Horro chicken. Chatterjee *et al.* (2006) had reported a higher shape index, 80.76 for IWK and lower indices for IWI (73.77) and IWH (72.67) strains of White Leghorn in agreement with the present result whereas similar shape indices were reported among some of the indigenous poultry breed of Andaman reported by Chatterjee *et al*. (2007) in India. Padhi *et al.* (1998) also reported lower shape indices in White, Brown, Black Nicobari birds, Naked neck and White Leghorn compared to the crosses studied in the same country.

The mean egg shape index (71.06%) documented for on-farm local Horro chickens produced under traditional management is also slightly lower than the normal range set between 72-76% which was reported by (Altuntas and Sekeroglu, 2008) and also lower than the 76% egg shape index reported for light chicken ecotypes in Nigeria. On the other hand, the result revealed that the shape of egg of the local Horro chicken is more oval than those whose egg shape index was larger. The overall mean egg-shell weight (4.33g and shell thickness (0.36±0.04)mm of Horro chicken in the present study is lower than the egg-shell weight 6g and higher than the egg-shell thickness 0.32mm respectively, reported by Pradeepta *et al.* (2015).

Haugh unit is the measure of albumin quality which determines the quality of the egg protein. The respective overall mean yolk weight (14.36 gm) and albumen weight (22.3 gm) measured and (73% Haugh Unit (HU) computed in the current study is lower than the reports by Momoh *et al*. (2010), who documented 18.3 gm yolk weight, 31.1 gm albumen weight, 79.1% HU for light ecotype, and 17.9 gm for yolk weight, 30.2 gm for albumen weight and 78.3% HU recorded for heavy ecotypes in Nigeria. However, the mean 14.32 gm yolk weight and 22.30 gm albumen weight recorded in this study is higher than the 12.3 gm mean yolk weight and 17.8 gm mean albumen weight reported by Gebreselassie *et al*. (2015) for local chicken in Tigray region in Ethiopia.

The variation in overall egg quality characteristics among the three agro-ecologies of the current study agrees with the report by Babinszky *et al.* (2011) who documented that the levels of performance of poultry, does not depend only on inherited capacity but, also to a great extent upon the environment. Sauter *et al.* (1954) and Washburn (1990) also documented a result that accords with the above finding where many factors influence the egg quality i.e., breed/ strain/ variety, temperature, relative humidity, rearing practices and season were concluded.

CONCLUSION

The egg quality characteristics studied for local Horro chicken produced under the highland, midland and lowland agro ecologies showed a significant difference though the difference varies for different traits. It could be concluded that the egg quality variation among the agroecologies might be attributed to the environmental differences, access to market and technologies that may determine improvement of husbandry and feed availability. In general, it can be concluded that agro-ecologic difference determines egg quality as the feeding-habit, seasonal variation and climate may affect the basal diets and feed supplements of scavenging chicken. For the chicken carcass characteristic study, the DZ white feathered chicken showed better performance in its live weight, and the carcass weight and the weights of different meat cuts. The better performance of white-feathered Dz might attributed to the feeding practice that favours this chicken breed as opposed to the Koekoek and improved Horro chicken who are known for their scavenging characteristics.

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