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Full Length Research Paper

Some internal and external egg quality characteristics of local and exotic chickens reared in Yirgalem and Hawassa towns, Ethiopia

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Analyzing eggs quality is so important for both consumers and for coming new chicks. Total of 300 eggs (100 eggs from each native, Sasso and Bovans brown) chicken were collected during winter of 2017 to evaluate some egg quality parameters of chickens reared at Yirgalem and Hawassa towns of Southern Ethiopia. The eggs were purchased from the householders and each egg was carefully broken on a glass sheet, and was analyzed for different quality traits. The results of the study indicated that the weight of the eggs highly varied between the genotypes and also within genotypes (between locations) the eggs of the native chickens weighed (45.20±5.53 and 39.30±4.04 g), while eggs of Sasso chickens weighed (56.40±7.07 and 56.00±7.2 g), whereas those of Bovans brown weighed (57.80±7.22 and 60.70±5.98 g) at Hawassa and Yirgalem towns, respectively. The results pertaining to the Haugh unit of the eggs (from Hawassa and Yirgalem) and of the native chickens was (74.91±15.78 and 82.55±3.82), while for Sasso chickens (86.50±11.07 and 87.04±11.10) and Bovans brown were (94.60±7.74 and 86.29±5.85), respectively. The Haugh unit of the egg from the native chickens was lower than exotic chicken; this was observed irrespective of the locations. It was concluded that egg quality of exotic chickens in the study areas performed fairly well, but it needs further comparative study under farmers' level and intensive farm.

Key words: Egg quality traits, exotic and local chickens, Southern Ethiopia.

INTRODUCTION

In Ethiopia, the evolution of the poultry sector (in recent times) has highlighted the growing importance of small and medium-scale producers residing in the urban and peri-urban areas (FAO, 2008). The increase in urban free-range poultry production can be ascribed to three

main reasons, viz, the local food movement itself has become very popular (which has sparked a new interest for many in backyard food production. Since chickens are one of the smaller protein producers, they fit well into a backyard food production model), rising cost of energy

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and transportation (resulting in concern over increases in food costs, and backyard eggs offer a cheaper solution as they do not have to travel far to reach the plate). It has also been observed that the urban residents are becoming increasingly concerned about food safety, especially those from the frozen foods (Labadie, 2008).

By focusing the preference of consumers, the food products from villages are particularly advertised as natural and fresh however in most of the cases the reverse is true as the chickens reared in the rural areas are exposed to several pests and parasites besides long marketing chain compromises with their freshness (Tugcu, 2006). Besides the same, eggs can also harbor various diseases which can be potentially harmful for the consumers alike (Avan and Alisarli, 2002; Rakonjac et al., 2014). The egg quality is influenced by both genetic and environmental factors, hens laying substandard eggs should be culled besides the management of the hens can help in improving the quality of eggs (Aberra et al., 2012). Eggs of unnatural shape and of poor shell quality too are not desired as such eggs usually have poor hatchability and even if the chicks hatch out they rarely survive or grow well (King'ori, 2011). Findings of a study by Meseret (2010) from Jimma zone, Oromia regional state of Ethiopia indicated that, eggs purchased from the market usually have lower values in all the quality parameters investigated.

The external egg quality traits include, shell thickness it is a measure of the shell strength mainly for the breeder flock incorporate and this assessed to reduce egg shell breakages (Bekel et al., 2009; Alewi et al., 2012). As the study by Melesse et al. (2010) indicated shell thickness for Ethiopian naked-neck chicken under station research chicken is 0.370 mm which is similar to the values for village chicken reared in Turkey as was reported by Kartalkanat and Cicek (2009). In contrast, Fayeye et al. (2005) reported that high shell thickness (0.580 mm) among scavenging chicken and the value for Fulani ecotype chickens of Nigeria. This variation of shell thickness observed in different region could be attributed to the quality, quantity and nutrient composition of scavengable feed resources available in different localities.

As regards the internal egg quality characteristics, thick albumen is quite an important measure for the freshness of an egg. Eggs stored for a long period of the time, leads to denaturation of albumin and thus the albumin is usually watery (Meseret, 2010). According to a study by Okeudo et al. (2003), the yolk color also have important factor for the consumers.

The importance of egg quality traits (external and internal) evaluation cannot be refused to think for both consumer and new born chicks; however, egg quality parameters of the different ecotypes of the chickens raised in the urban surroundings too have rarely been studied. Therefore, based on as discussed earlier, the study was conducted on egg quality traits of local and

exotic chickens in Hawassa and Yirgalem towns.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Hawassa city (7°03 latitude North and 38°28 longitude East at the elevation of the 1708 m above sea level (m.a.s.l) and Yirgalem town (latitude and longitude of 6°45'N 38°25'E and an elevation of 1776 m). Both locations are situated in the Sidama zone of the SNNPRs region of southern Ethiopia (IPMS, 2005).

Sampling techniques and sample size

Purposive sampling procedure was used. From the 8 sub-cities of Hawassa, 3 sub-cities were selected purposively based on the chicken populations of the area and as suggested by the authorities of the Bureau of Agriculture. The sub-kebeles within the sub-cities two kebele too were purposively selected based on the chicken population. While from Yirgalem town which has 9 kebeles, the 4 kebeles were selected purposively based on the aforementioned criteria. Among the selected kebeles, it was also purposively identified the people those who are rearing local and exotic breed of chickens.

Data collection procedure

Eggs from the local and exotic breed of chickens were collected for quality parameter test. The eggs were identified by the respondents themselves, care was taken to select only fresh eggs and the date of egg laid, the genotype were recorded on the shell of the eggs for proper identification. 150 eggs from each area, and then totally of 300 egg (100 of local and 200 of exotic breed (Sasso and Bovans Brown) of chicken were collected. The eggs were purposively collected based on the of similar aged pullets from family who rears local and exotic breed chicken and were brought to the Poultry Science laboratory of Hawassa University College of Agriculture.

Eggs were weighed using digital balance, with error margin of ± 0.01 g. Egg length and width was taken using digital caliper to nearest of 0.05 mm. Each egg was carefully broken on a glass sheet. The parameters such as: yolk height and diameter, albumen height, and yolk color were taken. Egg shell thickness was measured at the middle, large end and narrow end.

A tripod micrometer was used to measure the heights of albumen and Yolk. Yolk colour was measured by using the Roche Colour Fan (range 1-15) (Roche scale). Egg shell thickness was measured according to Aberra et al. (2012). Individual Haugh unit was also calculated according to the following equation of Haugh (1937).

$$Hu = 100 \log (H + 7.57 - 1.7EW^{0.37})$$

where H = albumen height, Hu = Haugh unit, and EW = egg weight.

Statistical analysis

Data were analyzed using SPSS version 16 (SPSS, 2007). The means of the quantitative traits were compared using Duncan Multiple Range Test, while two-way ANOVA was used to compare the values across the two studied locations (Duncan, 1995). The values were considered significant at 5% levels.

Table 1. Type of grains and non-conventional feed supplements (%) in the study areas.

Variable	Location			$(\chi^2 < 0.05)$
	Hw	Yr	Total	
Type of grain and non-conventional feeds				0.066
Wheat bran (<i>frushika</i>)	1.3	1.1	1.2	
Food leftovers (<i>injera</i> , bread, <i>kocho</i> and vegetables)	14.5	25.0	20.1	
Maize and wheat bran	13.2	3.2	7.9	
Maize, wheat bran, wheat, <i>kinche</i> and feed leftovers	11.8	8.0	9.8	
Maize, wheat bran and <i>kinche</i>	2.6	0	1.2	
Maize, wheat bran and food leftovers	56.6	62.5	59.8	

Hw: Hawassa, Yr: Yirgalem.

Table 2. External egg quality traits for local, exotic breed chicken in the study areas.

Parameter	Location	Breed types and their quality traits		
		Local (N=100) (Mean±SD)	Sasso (N=100) (Mean±SD)	Bovans Brown (N=100) (Mean±SD)
Egg weight(g)	Hw	45.20±5.53 ^a	56.40±7.07 ^b	57.80±7.22 ^b
	Yr	39.30±4.04 ^a	56.00±7.21 ^b	60.70±5.98 ^{*c}
Egg length (g)	Hw	52.39±2.43 ^{*a}	55.77±7.54 ^b	55.79±2.96 ^b
	Yr	50.39±3.83 ^a	55.63±7.56 ^b	55.39±3.02 ^b
Egg width (mm)	Hw	39.80±6.83 ^a	41.83±1.94 ^b	42.77±1.55 ^b
	Yr	37.86±1.24 ^a	41.71±1.99 ^b	42.65±2.72 ^b
Dry Shell weight (g)	Hw	3.93±0.78 ^a	4.28±0.23 ^b	4.38±0.59 ^b
	Yr	3.71±0.44 ^a	4.24±0.34 ^b	6.21±1.01 ^{*c}
Shell thickness (mm)	Hw	0.24±0.04 ^a	0.26±0.05 ^{*b}	0.24±0.029 ^a
	Yr	0.19±0.06 ^a	0.24±0.05 ^b	0.32±0.03 ^{*c}

Hw: Hawassa, Yr: Yirgalem, ^{a,b,c}Means with different superscripts across column (breeds) are significantly different (P < 0.05).

RESULTS AND DISCUSSION

Available feeds and feeding system of chicken in the study areas

Since the feed composition for laying hens have very effects on eggs quality, the available feed resource of chicken in the study areas is presented as the following. The results from Table 1 indicates that most of the respondents provide the chickens with home by-products or food leftovers (*injera*, bread, *kocho* and vegetables), scavenging and supplementary feeds such as Maize, Wheat, Wheat bran (*Frushika*) and *Kinche* (broken grains). There was no significant variation (P<0.05) observed on the types of the chicken feed available in the study areas. These results agreed with the findings of Wonda et al. (2013).

Quality evaluation of the eggs of the native and exotic chickens in the study areas

The external egg quality traits such as, egg width, length

and egg weight and shell weight are presented in Table 2.

Weight of egg

Table 2 reveals that the weight of the eggs were highest among those laid by the exotic genotypes. There was no variation observed (among the egg weight of the exotic breeds) at Hawassa, but the difference was observed at Yirgalem, the weight of the eggs being higher (P<0.05) for the Bovans Brown when compared with those laid by Sasso. The result of the present study on the egg weight (Table 2) for local chicken reared in Hawassa and Yirgalem was similar with the finding of several researchers from Ethiopia (Mesere, 2010; Aberra et al., 2012; Emebet, 2015). This might be ascribed with the genetics of the chickens, besides as weight of the birds and their eggs are correlated (Zita et al., 2009). The weight of the eggs are also correlated with the age of the chickens (Padhi et al., 2013), besides the feed availability as the chickens receiving less quantity of feed usually lay

small eggs (Isidahomen et al., 2013).

The eggs of the Sasso and Bovans chickens weighed higher than the eggs from the native hens, the findings are in close accordance with the reports of Desalew (2012) and Desalew et al. (2015) from Oromia region of Ethiopia. The egg size is a moderately heritable trait influenced by genotype-environment interaction ($G \times E$) (Gezahegn et al., 2016). The egg weight of the exotic chickens is optimum for the ecotypes and it is also expected that the chicks born from these eggs are also strong and hence have a higher weight (Ndofor-Foleng et al., 2015).

The farmers need to be careful with the nutrition of the exotic chickens as higher egg weight demand a better nutrition, which if not provided can seriously impair their productivity and also the hatchability of the eggs (Isidahomen et al., 2013). The respondents too need to be made aware of clean egg production and storage so as to ensure a better market acceptability and price of the eggs (Alemayehu, 2017).

Length of egg

The egg length too varied across the genotypes with higher ($P < 0.05$) values recorded among the exotic, the observations being consistent across the locations.

The results pertaining to the length of the eggs of the native and exotic chickens reared in the two study locations are presented in Table 2. The findings from the table show that the length of the eggs from the native chickens for Hawassa and Yirgalem, respectively was in agreement with the result reported by Aberra et al. (2012) from different agro-ecology of Amhara and Markos et al. (2017) from lowland area of Western zone of Tigray, who reported the value to be 51.3 and 53.8 mm, respectively. On the contrary, the trait was reported to be lower (48.3 mm) among the native chickens from Bangladesh (Islam and Dutta, 2010).

The egg length of Sasso and Bovans raised in Hawassa and Yirgalem were reported to be (55.77±7.54, 55.79±2.96 mm) and (55.63±7.56, 55.39±3.02 mm), respectively, which was in agreement with the finding of Islam and Dutta (2010) who reported the egg length for Cob 500 broiler to be 56.9 ±0.20 g. Contrary to the present findings, the value for Fayoumi-crosses and RIR-crosses reared at Gurage zone was observed to be 50.0 and 51.4 g, respectively (Alewi et al., 2012). Egg length varies across genotypes and also influenced by non genetic factors (Isidahomen et al., 2014).

Width of egg

The egg width too varied across the genotypes with higher ($P < 0.05$) values recorded among the exotic, the observations being dependable across the locations. The results pertaining to the width of the eggs from native and exotic chickens are presented in Table 2.

The findings show variations in the trait with the eggs from the native breeds having narrower width when compared with the exotic counterparts (Isidahomen et al., 2013). The width of the eggs from the native chickens are in agreement with the observations of Aberra et al. (2012) from Amhara region and (Markos et al. (2017) from mid-land agro-ecology of Western Tigray region. However, lower values for the character have been reported by Alewi et al. (2012), which can further be ascribed to the stage of egg lay, as it has been reported that at the beginning of egg lay the eggs are usually smaller and larger eggs are laid prior to moulting (Padhi et al., 2013).

The eggs from the exotic chickens were wider than those obtained from the native chickens, which can be ascribed to the genetic effects and also $G \times E$. The egg width values for the exotic chickens are in accordance with those of Islam and Dutta (2010) for exotic (Cob 500) breeds. However, the values were higher than those reported by Joseph (2013). The variations across the egg width of the different genotypes are in close accordance with those of Isidahomen et al. (2013); the differences also can be accorded to the differences in the genotypes and also $G \times E$ (Markos et al., 2017).

Dry shell weight

Egg shell weight too varied across the genotypes and locations, the weight being higher among the exotic genotypes, variations were also recorded across the locations, with higher ($P < 0.05$) shell weight among the Bovans Brown reared at Yirgalem. The variations being non significant between the other two genotypes reared in the two locations. The shell weight of the native chickens are lower (irrespective of the locations) from the values reported by Meseret (2010) who recorded that the weight of the shell of fresh and aged egg of the indigenous chickens was 4.61 and 4.35 g, respectively. The shell weight is also lower than what was reported by Markos et al. (2017) for chickens reared in the highland, midland and lowland 5.05, 4.72 and 4.30 g, respectively. Ahmedin and Mangistu (2016) from Eastern Hararghe, Ethiopia also revealed that higher value for shell weight.

The shell weight of the exotic chickens is in close agreement with the findings of Joseph (2013) from Tanzania which revealed that the shell weight for RIR chicken breeds was 4.68 g. Adedeji et al. (2008) from Nigeria revealed that shell weight of the Isa brown breed chicken was also significantly higher than those from Sasso and Bovans brown as recorded in this study. The observed variation on the shell weight could be due to availability of calcium in the diet and also the bioavailability of calcium and phosphorus (Pelicia et al., 2009).

Shell thickness

The findings also indicate that the shell thickness too

varied across the genotypes reared at the two locations. The shell thickness of the native and Bovans Brown chickens reared at Hawassa were consistent but differed ($P<0.05$) from the Sasso where the values were higher ($P<0.05$). The shell thickness of the eggs (across the genotypes of chickens) too varied across the locations, the values being higher for the Sasso hens reared at Hawassa while the reverse was true for the eggs of Bovans Brown chickens, where the values were higher at Yirgalem.

The result of Table 2 indicates that the shell thickness of the native chickens were lower than those reported by Meseret (2010) who reported that the shell thickness of the fresh and aged indigenous chicken eggs in Gomma woreda, Jimma zone, Ethiopia were 0.38 and 0.33 mm, respectively. Aberra et al. (2012) reported that the overall shell thickness for indigenous chicken in different agro ecologies of Amhara, Ethiopia was 0.296 mm. Similarly, the shell thickness of the local Kei chickens was 0.309 mm (Alewi et al., 2012).

The results also show differences in the shell thickness among the Bovans and Sasso chickens the values being lower than those reported by Desalew et al. (2015) for Isa brown, Bovans brown and Koekoek breeds reared in rural kebeles of East-Showa. The thickness is also lower than those reported by Joseph (2013) for Green shanked indigenous (GSI) and Red shanked indigenous (YSI).

Egg shell thickness varied across the ecotypes and the locations of the study; these observations are in accordance with those of Aberra et al. (2012) who reported that the variation of the shell thickness could be attributed to the quality, quantity, nutrient composition of the feed available to the birds which of course will vary across the locations.

The trait being moderately heritable is also influenced by the genotype of the bird and the calcium and phosphorus metabolism which vary across the age of the bird and also the bioavailability of the two mentioned nutrients (Pelicia et al., 2009; Aberra et al., 2012). This trait too is of commercial importance as eggs with thick and strong shells are usually the most marketable (Abera et al., 2010).

Internal quality of the egg of the native and exotic chickens in the study areas

The internal egg quality traits (Table 3), viz, yolk height, albumen height, yolk width, yolk color, Haugh unit were calculated.

Yolk height

The results indicate that yolk height was higher ($P<0.05$) among the exotic genotypes which was consistent across the two locations, the albumen height too varied across

the genotypes with the values being higher among the exotic chickens. The values too differed across the exotic genotypes being higher among the eggs of Bovans Brown laid at Hawassa. However, there were no differences across for the trait among the eggs of the exotic chickens reared at Yirgalem. The yolk height of the eggs from the native and exotic birds (Table 3) indicates that the values as recorded in the study are in agreement with the findings of Markos et al. (2017) who reported that yolk height of eggs collected from the highland, midland and lowland areas in Western zone of Tigray was 17.2, 14.9 and 13.5 mm, respectively. The findings are in close agreement with those of native chickens from Amhara region (Abera et al., 2012). The value as recorded by Alewi et al. (2012) from Gurage zone indicated higher yolk width (17.0 mm) among local Kei chicken.

The result obtained for the exotic chicken Sasso and Bovans brown collected from both study locations were in consonance with finding of Desalew (2012) from East Shewa. The values also were in close accordance with the observations of Alewi et al. (2012) from Gurage zone and for Fayoumi chicken (17.3 mm). The values were higher than the findings of Nebiyu (2016) who reported the yolk height of Bovans brown chicken (16.2 ± 0.06 mm) raised under urban production system in Addis Ababa. The present results are also higher than the reports of Adedeji et al. (2008) and Ahmedin and Mangistu (2016) for eggs collected from exotic chickens reared in Nigeria and Eastern Hararghe, respectively.

Yolk width

The yolk width also varied across the genotypes with the values being higher among the eggs of Sasso hens. The yolk width did not vary across the other two ecotypes. The yolk width values of native chicken reared at Hawassa and Yirgalem, respectively were higher than the observation of Aberra et al. (2012) who reported the value of yolk width of 36.80 ± 0.175 mm. The values in the study were also higher than those reported in a study by Alewi et al. (2012) for local Kei chicken (36.3 mm) reared at Gurage zone.

The yolk width of Sasso and Bovans brown chicken reared at Hawassa and Yirgalem, respectively was higher than the values reported by Alewi et al. (2012) (37.1 and 37.5 mm) for Fayoumi-crosses and Rhode Island Red chicken reared at Gurage zone breeds, respectively; report by Rath et al. (2015), contrary to the same the yolk width of the White Leghorn chickens were higher (44.72 ± 0.11 mm) than those of the two exotic ecotypes in the present study. The differences as observed might be ascribed to both genetic and Gx \times E (Fassill et al., 2009).

Albumen height

The result of the current study on albumen height of the

Table 3. Internal egg quality traits for local, exotic breed chicken reared in the study areas.

Parameter	Location	Breed types and their quality traits		
		Local (N=100) (Mean±SD)	Sasso (N=100) (Mean±SD)	Bovans brown (N=100) (Mean±SD)
Yolk height (mm)	Hw	15.77±2.11 ^a	17.19±1.32 ^b	17.48±1.99 ^b
	Yr	15.90±1.02 ^a	17.25±1.27 ^b	17.70±2.49 ^b
Albumen height (mm)	Hw	5.20±1.24 ^a	7.51±2.09 ^b	8.98±1.67 ^{*c}
	Yr	5.7±0.59 ^{*a}	7.59±2.11 ^b	7.52±1.06 ^b
Yolk width (mm)	Hw	40.91±2.70 ^{*ab}	41.32±4.99 ^b	39.35±1.77 ^a
	Yr	38.70±1.68 ^a	40.95±4.93 ^b	38.61±4.00 ^a
Yolk color	Hw	9.16±1.42 ^b	9.24±1.67 ^b	7.26±1.21 ^a
	Yr	9.22±1.46 ^b	9.36±1.83 ^b	7.66±1.49 ^a
Haugh unit	Hw	74.91±15.78 ^a	86.50±11.07 ^b	94.60±7.74 ^{*c}
	Yr	82.55±3.82 ^{*a}	87.04±11.10 ^b	86.29±5.85 ^b

^{a,b,c}Means with different superscripts across breeds are significantly different ($P < 0.05$), ^{*}= value across column are different ($p < 0.05$).

local chicken eggs in both the studied locations was similar to the findings of Markos et al. (2017) who reported that the height of albumen among eggs of indigenous chicken collected from highland, midland and lowland agro-ecologies of Western zone Tigray, was 5.66, 5.65 and 5.05, respectively. The results are also in agreement with the findings of Alewi et al. (2012) and Mube et al. (2014) for local Kei chicken (5.79 mm) raised in Guraghe zone and also native chickens (5.74 mm) from Cameroon, respectively. The lower values for the trait have also been reported by Meseret (2010) and Aberra et al. (2012 for fresh eggs at 2.87 and 4.51 mm, respectively from indigenous chicken reared at Jimma and Amhara.

The albumen height of Sasso and Bovans brown chicken reared in the studied locations are in agreement with the observations of Nebiyu (2016), who reported the albumen height of (7.1±0.08) for Bovans brown chicken eggs under urban production system in Addis Ababa. The values were however higher than those reported by Desalew (2012) for Isa brown, Bovans brown and koekoek chicken (6.30 ±1.85, 6.92 ±1.62 and 5.64 ±1.55), respectively. The findings from this study are however lower than what was reported by Rath et al. (2015) for eggs from White leghorn chicken (8.41±0.04 mm). The albumin height of the eggs of Isa brown, Bovans brown and Koekoek chicken was lower (6.34±1.81, 6.92±1.62, and 5.54±1.35 mm) than the present study as reported by Desalew et al. (2015) from East Shewa. The observed variation on albumin height is correlated with the freshness of the eggs (Meseret, 2010); and also influenced by several non genetic factors besides the G x E values.

Yolk color

The pigmentation of the yolk is basically due to the presence of xanthophylls in the diet received (Desalew, 2012; Aberra et al., 2012). The scavenging chickens usually have deeper color of the yolks as they are able to obtain the pigments from the plant parts scavenged by them (Desalew, 2012). Studies (Hatungimana et al., 2015) have also reported that chickens receiving yellow maize have deeper color when compared with those receiving white maize. Pigmentation of yolk also depends on any factor which inhibits liver function and subsequent lipids metabolism of the chickens and hence even with similar amount of pigments there can be variation in the yolk color (Zaghini et al., 2005)

The result of current study on yolk color of Sasso and Bovans Brown chicken indicates variation across the genotypes which irrespective of the locations were deeper in the later type of chickens. Yolk color of the Isa brown, Bovans brown and Koekoek chickens were in accordance with the findings of Tadesse et al. (2013) from East Shewa revealed. The yolk color of the eggs from Bovans Brown hens reared at some farms in Addis Ababa was lighter when compared with the present findings (Nebiyu, 2016). The variation in the varied pigmentation is influenced by the diet of the chickens; the pigmentation being deeper among the chickens reared under scavenging system when compared with those reared at commercial farms (Tulin and Ahmet, 2009).

Haugh unit

The haugh unit was calculated to be the lowest ($P < 0.05$)

among the native ecotypes while variation too was observed across the exotic genotypes. The values being higher among the Bovans reared at Hawassa, with the values of the Sasso type being intermediate, while no differences were recorded for the two exotic genotypes reared at Yirgalem. The result of current study on haugh unit (HU) of the native chickens reared in the two studied locations indicate that values were in accordance with those of several authors (Aberra et al., 2012; Ahmedin and Mangistu, 2016) from Ethiopia (for eggs collected from Hawassa). The values being lower than those reared at Yirgalem which are in accordance with the results of Alewi et al. (2012) from Guraghe zone. The HU of the eggs from the native chickens on these results was higher than those reported by Meseret (2010) for fresh and aged eggs (54.50 and 46.74), respectively.

The result of the current study on HU of Sasso and Bovan's brown chickens reared in the two locations was higher than those reported by Alewi et al. (2012) for Fayoumi-crosses and Rhode Island Red-crosses from Guraghe zone. The values are however in close accordance with those reported by Ahmedin and Mangistu (2016) from improved breeds of chickens reared in Eastern Hararghe. Contrary to the present results, the HU of eggs from Bovan's brown hens reared in Addis Ababa was lower than the present findings and Rath et al. (2015) for White Leghorn. Nebiyu (2016) also reported lower HU of 83.3 ± 0.45 for Bovans brown chicken eggs under urban production system in Addis Ababa. The observed variation on HU of the egg was in agreement with the suggestion of Aberra et al. (2012) who reported that the value of the HU vary due to factors such as management, quality and quantity of the feed and production environment in which the animals are maintained.

CONCLUSION AND RECOMMENDATION

The result of the present study on some egg quality parameters in two selected towns of Southern Ethiopia; the study indicated that in spite of suboptimal management and feeding egg quality of the exotic chickens was higher than those of the native chickens. And differences were also observed in the egg quality traits between the genotypes reared in the two locations, which can be ascribed to genotype by environment interactions. So then, it is perceived that if the chickens are provided with scientific management, the egg quality of the chicken can improve significantly.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Full Length Research Paper

Socio-economic perception of snail meat consumption in Fako division, south-west region Cameroon

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Cameroon south-west region offers favorable climatic conditions for survival of land snails whose meat is known for their nutritional benefits. Besides, conventional livestock (beef, chicken, etc.) cannot satisfy the high demand in Cameroon. Hence, snail meat could be suitable alternative source of protein. Therefore, this article investigated the perception and identified the main determinants of land snail meat consumption in the Fako division (south-west region Cameroon). A multistage random sampling method was used to select a total of 211 respondents. Descriptive statistics has highlighted that snail meat is quite consumed in Fako with 76.30% of respondents. Majority of respondents were Christians (95.26%) and have their origin from south-west region (56.40%). Additionally, regression analysis has pointed out that snail meat consumption depends on marital status, household size, income, snail origin and religion. The amount of snail meat consumed was shown to be influenced by its price and price variation between seasons. At the end of this study, two recommendations were made: snail farming should be increased in order to reduce scarcity of snail during dry season as well as its price and educate the people coming from other region of Cameroon on the nutritional benefits of snail meat.

Key words: Snail consumption, African garden snails, Cameroon.

INTRODUCTION

The rate of under-nourishment in Cameroon has been about 16% household being underfed in the country as at 2017 (World Food Programme and Ministry of Agriculture and Rural Development, 2017). In fact, one of the problems of malnutrition in humans is the low consumption of animal protein (Schönfeldt and Hall, 2012). FAO Statistics of 2013 indicate that protein consumption in Cameroon is currently 61.96 g/capita/day, that is, below FAO norm, estimated at 81.23 g/capita/day

(FAO, 2013). Hence, the low consumption of protein could be due to the fact that breeding of conventional species in Cameroon (beef, chicken, etc.) is still in majority traditional and cannot satisfy the high demand of Cameroon population in terms of protein requirements per individual (Labonne et al., 2003). Besides, the prices of conventional species in the market are less affordable for the middle class of Cameroonian households (Labonne et al., 2003). Therefore, people have turned to

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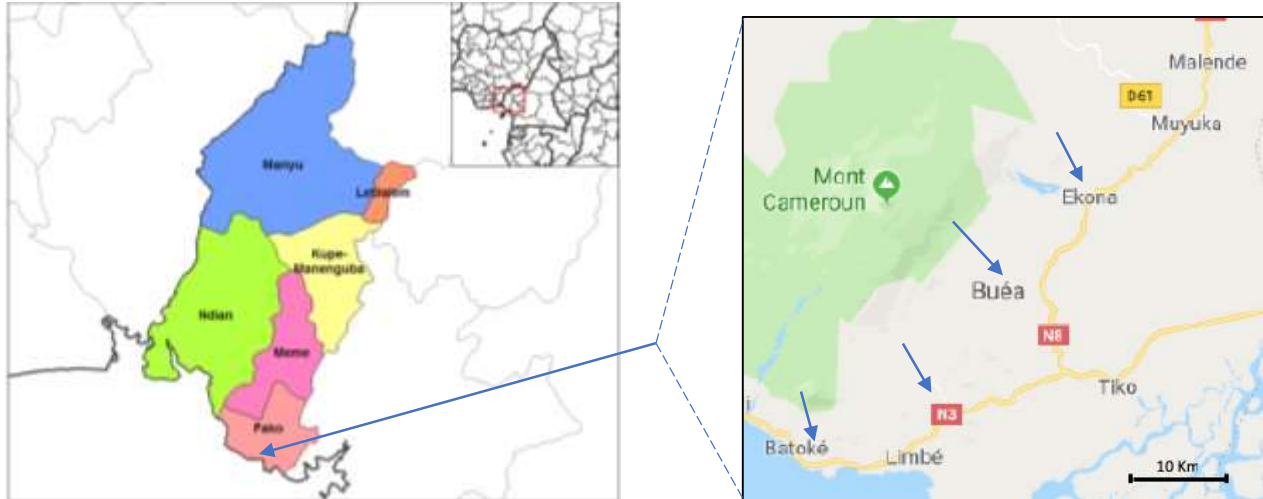


Figure 1. Map of the study area
Source: Wikipedia (2006); Google Map (2018).

the consumption of non-conventional species such as snails that were previously reserved for certain ethnic groups, particularly those from the south-west region (Ndah et al., 2017; Ngenwi et al., 2010). As in the south of Nigeria, the region nearby to Cameroon south west region, land snail meat consumption is common (Cobbinah and Vink, 2008). The major varieties of edible land snails found are *Achatina achatina* and *Achatina fulica* (Cobbinah and Vink, 2008). Besides, various studies have recommended snail meat to all ages (Malik et al., 2011; Adeyeye and Afolabi, 2004; Babalola and Akinsoyinu, 2009; Fagbuaro et al., 2006; Eneji et al., 2008). Since, snail meat was reported to be rich in proteins, low in fats and carbohydrates (Malik et al., 2011; Adeyeye and Afolabi, 2004; Babalola and Akinsoyinu, 2009; Fagbuaro et al., 2006; Eneji et al., 2008). Snail meat also contains several minerals such as calcium, phosphorus, potassium, iron and zinc (Engmann et al., 2013; Babalola and Akinsoyinu, 2009). In addition, it contains an additional source of essential amino acids such as Lysine and Arginine (Fagbuaro et al., 2006). Besides, its nutritional values, snail meat is more affordable than conventional livestock in Cameroon according to the prices in the market. Furthermore, the snail meat sector is a lucrative sector and source of income for several people in the south-west region that includes snail rearers, collectors, cleaners and vendors (Ndah et al., 2017; Ngenwi et al., 2010). With social crisis and increase of refugees ongoing in some region of the country, could snail meat be an alternative solution to food insecurity in Cameroon? There is a need to characterize the state of consumption of land snail consumption in Cameroon, particularly in the south-west region where it is very available. Therefore, objective of this study is firstly to identify the perception of snail meat consumption in the Fako division, south-west region of

Cameroon. Secondly, assess parameters that determine its consumption.

MATERIALS AND METHODS

Description of the study area

This study was conducted in the Fako Division, South West Region of Cameroon (Figure 1). The division is located at Latitude 4.1667° and Longitude 9.1667°. It covers an area of 2,093 km² and in 2014 had a total population of 1, 515, 888 inhabitants (Institut National de la Statistique, 2015). Of the six divisions in the South West region, Fako is a cosmopolitan area with numerous urban and semi-urban towns (Institut National de la Statistique, 2015). Besides, the division belongs to a humid forest with monomodal rainfall which offers favorable climatic conditions for the reproduction and development of land snails which is consumed as traditional meal.

Types and instrument of data collection and sample size process

Data used for the study were collected from 4 randomly selected areas in Fako division: Ekona, Buea, Limbe and Batoke as indicated in Figure 1, using a well-structured pre-tested questionnaire. Data were collected according to the socio-economic characteristics of the respondents (age, gender, household size, marital status, level of education, income, etc). Additional questions were related to snail consumption perception (quantity consumed, snail origin, determinants factors of consumption, eating form, and experience in snail consumption). A multistage random sampling method was used to select a total of 211 respondents that constituted the sample size. Descriptive statistics allowed the organization of the data (Table 1).

Data analysis

Data collected were statistically analyzed by using descriptive statistics and ordinary least squares multiple regression method of Stata 12.0 and Excel 2013. For regression calculation, snail meat

Table 1. Description of main socio economics characteristics.

Parameter	Description	Code
Sex	Gender of consumer	1=Male; 2=Female
Age	Age in year	1-<30; 2-30-40; 3-40-50; 3-50-60; 4->70
Marstat	Marital status	1=Single; 2=Married; 3=Separated; 4=Divorced, 5=Widow
Religion	Religion of the consumer	1=Christian; 2=Muslim; 3=Others
Housesize	Size of the household	Number of people in the house
Edulevel	Level of education	1-Primary; 2-Secondary; 3-Tertiary
Mainact	Main activity	1-Farming; 2-Trading; 3-Civil servant; 4-Artisan; 5-Other
Income	Salary per month (thousands of FCFA)	1=<30; 2=30-50; 3=50-75; 4=75-100; 5=>100
Snailcons	Consumption of snail's meat	1-Yes; 2-No
Consfrequency	Frequency of consumption	0-None; 1-Occasionally; 2-Each week; 3-Each month; 4- Other
Snailprice	Amount spent to buy snail meat	Amount in FCFA
Quantity (estimation of bowl used to sell snail meat in the market)	Quantity consumed	Quantity consumed (kg)
Snail origin	Snail meat origin	1-Farm; 2-Market; 3-Others
Eating form	Eating form preference	1-Grilled ; 2-Inside sauce; 3-Both; 4-None

Source: Data from the Field Survey (2018).

consumption model is tacitly specified as:

$$C = \beta_0 + \beta_1 \text{Age} + \beta_2 \text{Housesize} + \beta_3 \text{Edulevel} + \beta_4 \text{Income} + \beta_5 \text{Eating form} + \beta_6 \text{Quantity} + \beta_7 \text{Frequency} + \beta_8 \text{Price} + \varepsilon$$

where C = Consumption of snail's meat (decision to consume snail's meat), β_i = econometrics coefficients of parameters with $i = 1, 2, 3, \dots, 8$, and ε = disturbance.

RESULTS

Socio-economic characteristics of respondents

Results showed that 52.13% of the studied sample were male while 47.87% were female (Table 2). Majority of respondents were between 0 and 30 years (49.76%) followed by the range of 30 to 40 (34.18%). The majority of respondents were married (50.24%) and single (45.50%). The majority had a study level which ranged between the secondary and tertiary level. Household size ranged from 3 to 4 persons as reported by 38.86% of

respondents. Concerning the main activity of the interviewed people, civil servants (31.75%) were more represented, followed by traders (25.59%), then students (19.91%). The level of income is ranged between 30.000 and 100.000 FCFA. Most of the respondents are Christian (95.26%) and their region of origin is mostly the south-west region (56.40%).

Snail meat consumption perception

Parameters of snail consumption are shown in Table 3. It was indicated that a large number of respondents 76.30% eat snail meat while 23.70% do not. Actually, 36.49% of the respondents presented good taste as main determinant of consuming snail meat. Other reasons of snail meat consumption as identified by the respondents include formation of blood cells, source of proteins and economic factor. Cultural taboo, not familiar to snail dislikes the taste, were the factors that prevent some of the respondents from snail consumption.

Table 2. Socio-economic characteristics of the studied sample.

Parameter		Frequency	Percentage	Mean
Gender	Male	110	52.13	1.478673
	Female	101	47.87	
	Total	211	100	
Age	>30	105	49.76	1.687204
	30-40	70	33.18	
	40-50	33	15.64	
	60-70	3	1.42	
	Total	211	100	
Marstat	Single	96	45.50	1.582938
	Married	106	50.24	
	Divorced	6	2.84	
	Widow	3	1.42	
House size	Total	211	100	4.71564
	1-2	37	17.53	
	3-4	82	38.86	
	5-6	47	22.27	
	7-8	26	12.32	
	9-11	19	9.00	
Edulevel	Primary	16	7.58	2.393365
	secondary	97	45.97	
	Tertiary	98	46.44	
	Total	211	100	
Mainact	Farming	39	18.48	/
	Trading	54	25.59	
	Civil servant	67	31.75	
	Artisan	9	4.27	
	students	42	19.91	
	Total	211	100	
Region of origin	South west	119	56.40	/
	North west	47	24.17	
	Littoral	17	8.06	
	West	23	10.90	
	North	5	2.37	
	Total	211	100	
Religion	Christian	201	95.26	1.047393
	Muslim	10	4.74	
	Total	211	100	

Source: Data from the Field Survey (2018).

Furthermore, 66.82% of respondents acquired their snail meat from the market, 9.48% from the farm, while

23.69% from both market and farm. Regarding the form of consumption, 36.49% of respondents eat snail meat

Table 3. Parameters of snail's consumption.

Parameter		Frequency	Percentage
Snailscons	Yes	161	76.30
	No	50	23.70
	Total	211	100
Determinants factors of consumption	Blood formation	47	22.27
	Tasty	77	36.49
	Proteins	25	11.85
	Economical	12	5.69
	Don't like it	24	11.37
	Not use too	6	2.84
	Cultural taboo	20	9.48
	Total	211	100
Snail meat origin	Market	141	66.82
	Farm	20	9.48
	Others	50	23.69
	Total	211	100
Eating frequency	None	50	23.70
	(Occasionally)	47	22.27
	Weekly	64	30.33
	Monthly	50	23.70
	Total	211	100
Form of snail meat eaten	Fried (Soya)	52	24.64
	Inside Soup	77	36.49
	Fried, inside soup	32	15.17
	None	50	23.70
	Total	211	100
Snail price appreciation	Yes	154	72.99
	No	57	27.01
	Total	211	100

Source: Data from the Field Survey (2018).

inside soup, while 24.64% eat it grilled. About the frequency of consumption, 30.33% of respondents consume snail meat weekly, 23.7% monthly, while 22.70% daily and 23.70% occasionally. When interrogated about snail meat price in the market, 72.99% of respondent said that it is expensive while 27.01% do not.

Results from Table 4 showed that the average of snail consumed by respondents is 3.08 kg. In addition, it was also shown that the amount in average disbursed by respondents to buy snail in the market is around to 3000 FCFA.

Statistical regression model

Table 5 shows the result of regression of decision to consume snail meat between all the parameters of the

study. These results showed that there is a significant correlation at 1% between the decision to consume snail meat and the following parameters: marital status, income, snail origin, quantity of snail and religion. Similarly, a significative correlation of 5% between snail consumption and household size.

Table 6 shows the regression results of snail meat quantity consumption between 4 parameters: house size, snail price, price changing period and eating form. The results showed that there is a significant correlation at 1% between the quantity of snail consumption and the price of snails, and at 5% with the price changing period.

DISCUSSION

The objective of this study was to identify the perception and determinants of snail consumption in the Fako

Table 4. Distribution of some socio-economic parameters of snail consumption.

Parameter	Obs.	Mean	Std. Dev.	Min.	Max.
Consexp	211	11.52607	9.258357	0	35
Income	211	2.758294	1.422059	1	5
Quantity	211	3.081754	3.201675	0	20
Snailprice	211	2937.915	2717.086	0	15000
Price appreciation	211	1.270142	0.4450891	1	2
Price changing period	211	1.014218	0.1186701	1	2

Source: Data from the Field Survey (2018).

Table 5. Regression result of decision of snail meat consumption.

Linear regression

Number of obs.=211
 F(16, 194)=79.54
 Prob>F=0.0000
 R-squared=0.8677
 Adj R-squared=0.8568
 Root MSE=0.16129

Snailscons	Coeff.	Standard Error	P> t
Gender	0.027407	0.0180659	0.142
Age	0.0266096	0.0189007	0.337
Marstat***	0.181954	0.0046077	0.010
Housesize**	0.011927	0.020926	0.032
Edulevel	0.0453304	0.0094646	0.118
Mainact***	0.0124174	0.0015845	0.000
Consexp	0.0092369	0.0086055	0.284
Income***	0.0444666	0.0114828	0.000
Consfrequency	0.0036247	0.0047221	0.444
Quantity***	0.0979535	0.0244912	0.000
Snailorigins***	0.0000239	5.72e-06	0.000
Snailprice***	0.0818777	0.0266815	0.002
Priceappreciatio	0.1633416	0.0974191	0.095
Pricechangingperiod***	0.1789202	0.0153234	0.000
Eatingform	0.1069955	0.0567397	0.061
Religion**_cons	0.718624	0.1547055	0.000

***Value significant at 1%; **Value significant at 5%.

Source: Data from Survey (2018).

Department.

Percentage of women and men interviewed were similar. In addition, the studied sample is composed of young people (0-40 years old). This result showed that the studied sample is representative of the Cameroonian population that comprised a young population and a similar percentage between women and men (Institut National de la Statistique, 2015). Most of the respondents are educated beyond primary school and have a job. This implies that the answers given during this questionnaire

could be considered and it is a guarantee of validity of this study.

Majority of people interviewed have for region of origin the south-west. Indeed, this result justifies the consumption of snails being important in the study population since south-west region where Fako division belongs is a humid forest with monomodal rainfall which offers favorable climatic conditions for the reproduction and development of land snails (Cobbinah and Vink, 2008; Chukwuka et al., 2014). In addition, tribes of the

Table 6. Regression result of quantity of snail meat consumption.

Linear regression			
Number of obs.=211			
F (16, 194)=10.32			
Prob>F=0.0000			
R-squared=0.8197			
Adj R-squared=0.7851			
Root MSE=2.4485			
Quantity	Coeff	Standard Error	P> t
House size	0.1162846	0.0706552	0.101
Snail price***	0.0005123	0.0000829	0.000
Price changing period**	3.654077	1.466317	0.014
Eating form	0.5112772	0.3013252	0.091
_cons	2.728105	2.467996	0.270

***Value significant at 1%; **Value significant at 5%.
Source: Data from Survey (2018).

area have integrated land snails consumption as their cultural meal (Ngenwi et al., 2010; Ndah et al., 2017).

Most of respondents of the study are Christians. It could be explained by the fact that south-west region is part of the “greater” south of Cameroon, that is, Christian (Institut National de la Statistique, 2015). Furthermore, correlation analyses have shown that religion influences the consumption of snails. However, there is no law that forbid christians to consume snails except those who are from ethnic groups that consider snails as a taboo and do not consume it. As of Muslim who said not to eat snail meat, there is also no religious law that prohibits them to eat snail. Besides, the majority of Muslims in Cameroon are from the Sudano-Sahelian area (Institut National de la Statistique, 2015) and the climatic conditions are not favorable to the reproduction and the survival of the terrestrial snails (Cobbinah and Vink, 2008; Chukwuka et al., 2014). As a result, they do not consume snails because they have not been in contact with it culturally as people origin from the South.

The present results showed that snail meat is consumed in a regular basis and the majority of respondents gets it from the market. Indeed, correlation analysis confirms this result that the origin of snails is a determining factor of its consumption. Besides, many of them think that the price is high. This result could explain the fact marital status, household size and income were revealed as factors determining the consumption of snails. Indeed, when married, more important will be the size of the household, the quantity of snail meat to consume will be important and the price of snail meat will consequently influence its consumption. Furthermore, this study has revealed that there is a correlation between the main activity and the decision to consume snails. Indeed, if somebody has an income he could

easily afford snail meat.

Moreover, it showed that there is a correlation between quantity of snails consumed and the price variation according to the season. Indeed, there are still very few snail farms and snails are still supplied by harvesting in the fields and around houses (Ngenwi et al., 2010; Ndah et al., 2017). In addition, snails hibernate during the dry season and become rare (Chukwuka et al., 2014). Consequently, snail meat price's increases during dry season and less important will be their consumption because of the price increase.

Definitively, this study has highlighted that snail meat is very consumed in the Fako division. It has also been shown that consumption is dependent on marital status, household size, income, snail origins and religion. In addition, it has been pointed out that snail meat consumption quantity is influenced by its price and price variation according to season. Even though, the sample has some characteristics of Cameroon population, this result is specific to the study area. To have general recommendations, it will be interesting to extend the study to the other regions of Cameroon. According to results pointed out from this study, two recommendations can be made. Firstly, snail farming should be increased in order to reduce scarcity of snail during dry season as well as its price. Secondly, people coming from other regions of Cameroon than south-west should be educated on the nutritional benefits of snail meat. One of the limitations of the study was not to be able to apply the questionnaire in some town of Fako division because of social crisis in the south-west region. Next step of this study will be firstly, to extend the survey in other division of the region as well as other regions of Cameroon with the same climatic conditions. Secondly, interview land snail collectors in order to evaluate the methods of supplying land snails.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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