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A study on physical egg quality characteristics of exotic and indigenous poultry breeds in Juba town-South Sudan

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Abstract: This study was conducted in the University of Juba Animal Production Farm to compare the egg quality characteristics of the exotic Rhode Island Red with the indigenous Baledy poultry breeds in Juba Town - South Sudan. Twenty five eggs from each breed were collected and some physical egg quality traits including egg weight, egg length, egg width, egg shape index, egg specific gravity, egg yolk length, egg yolk width, egg yolk index, albumen height and shell thickness were measured. The data were managed and analysed using ANOVA. The results showed highly significant differences (p<0.0001) for the egg weight mean value of (56.04 ± 0.78) and (23.50±1.99) for the exotic and indigenous poultry breeds, respectively. Egg length, egg width, egg shape index, egg specific gravity, egg yolk index, albumen height and egg shell thickness were highly significant (p<0.0001) showing mean values of 5.72 ± 0.04), (4.98 ± 0.07); (4.09±0.02),(3.54± 0.04); (96.37 ± 0.26), (98.20±0.26); (1.04 ± 0.01), (0.96 ± 0.01); (1.04 ± 0.01), (1.06 ± 0.01); (3.97 ± 0.02), (3.31± 0.04) and (0.31 ± 0.00),(0.28± 0.00) for exotic and indigenous poultry breeds, respectively.While the respective egg yolk length (3.31 ± 0.06), (3.09±0.05) and yolk width (2.97 ±0.03),(2.70 ± 0.04) were significant (p<0.001) and with the least significant differences (p <0.05). Further study on other indigenous poutlry breeds is needed for improving egg hatchability in South Sudan.

Key words: Egg quality traits, Exotic poultry breed, Indigenous poultry breed, Egg hatchability, South Sudan

INTRODUCTION

The indigenous chickens constitute a significant contribution to human livelihood and food security of poor households in most African countries (Mlozi *et al.*, 2003). Poultry production is an important agricultural activity of almost all rural communities in Africa, providing scarce animal protein in the form of meat and eggs as well as being a reliable source of petty cash, savings, investment, insurance and serve in traditional medicine (Mlozi *et al.,* 2003). The importance of indigenous poultry breeds in the national economy of developing countries and its role in improving the nutritional status and income of many smallholder farmers and landless communities has been very significant (FAO, 1997 Mwalusanya *et al.*, 2001).

It is clear that the eggs quality and their stability during storage are largely determined by their physical structure and chemical composition (Seidler, 2003). The physical factors most generally appreciated in eggs are shell appearance and strength, egg size, weight and physical appearances of internal structures (Seidler, 2003). The internal physical quality factors include appearance of albumen and yolk, Haugh unit and yolk index (Tharrington *et al.*, 1999 Zaman *et al.*, 2005). Moreover, these egg quality traits have significant and direct effects on the prices especially when the eggs are graded (Seidler, 2003). Very few studies have been carried out to characterize, evaluate and understand the quality of eggs produced from indigenous breeds in South Sudan and this makes it difficult to establish quality standards, grades and possibly expand egg market to export level. This may also be difficult to provide tangible advice to farmers on the appropriate requirements for good quality egg production.

The current study aimed to determine some physical egg quality characteristics of indigenous eggs produced in Juba Town compared to the eggs of exotic breeds. Such baseline information will be useful to key stakeholders including the local producers for improving the eggs and their hatchability.

MATERIALS AND METHODS

Study Area

The study was conducted at the University of Juba campus laboratory using eggs brought from Radolo farm of the Central Equatoria State Ministry of Animal Resources and Fisheries demonstration farm.

Management of Experimental Birds

Two poultry breeds of exotic (Rode Island Red) and indigenous (Baledy) were used as experimental birds. The exotic breed has been reared in the Radolo farm under intensive system. The birds were vaccinated against Newcastle disease, Gumboro, Marek's and Fowl Pox diseases. They were fed on formulated feed and left to lay for a period of 3 months. Then 25 eggs from each breed were collected for egg quality experiment for both internal and external qualities. Eggs of indigenous Baledy breed due to their rareness were brought from rural areas housed in a free range system when reaching a laying period of three months.

Chemical Composition of Eggs

The Chemical composition of the whole eggs, albumen and yolk is shown in table 1.

Table 1: Chemical composition of eggs.

Parameter	Percent	Water (%)	Protein (%)	Fat (%)	Ash (%)
Whole egg	100	65.5	11.8	11.0	11.7
Albumen	58	88.0	11.0	0.2	0.8
Yolk	31	48.0	17.5	32.5	2.0

Source: Rogler, E. Moreg. And Johe, S – Avens (1970).

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Egg Quality Assessment

Egg quality traits were measured following standard operating procedures (SOPs) as described by Monira *et al.,* (2003). Briefly, the external egg quality traits investigated include, egg weight (g), shell colour, shell texture, shell cleanness and shell soundness. The shell colour was assessed by naked eyes while shell texture was examined through palpation. Egg weight was determined using an electronic weight scale. The shell micro cracks were assessed using an egg candler. Similarly, internal egg parameters which were measured include, shell weight (g), shell thickness (mm), general appearances of internal egg parts, smell, albumen weight (g), albumen height (mm), yolk height (cm), yolk width (cm), yolk weight (g), yolk index (%) and Haugh unit.

Each egg was later carefully broken to release the albumen and yolk taking care for the intact of vitaline membrane. The yolk and albumen were then carefully separated and placed in separate petridishes, which had initially been weighed. The difference in the weight of each petridish after and before the introduction of the yolk and albumen was taken as the weight of the yolk and albumen, respectively. The yolk and albumen heights were determined using a tripod micrometer. Yolk index was calculated as a ratio of the yolk height to its width as follows:

$$Egg\ yolk\ Index = \frac{Yolk\ height}{Yolk\ width}\ x\,100$$

Any abnormalities or defects observed in the albumen and yolk were recorded. Shell weight (shell membrane inclusive) was obtained by weighing on the electronic scale. The thickness of each shell was determined using a micrometer screw gauge. Accuracy of shell thickness was ensured by measuring shell sample at the broad end, middle portion and narrow end of the shell. Individual Haugh unit (Haugh, 1937) score was calculated using the egg weight and albumen height as follows:

$$\mathbf{HU = 100\ log\ (H+7.6\text{-}1.7W^{0.37})}$$

Where, HU = Haugh Unit,
H = observed height of the albumen in millimeter (mm),
W = weight of egg in grams (g).

Objective Method (measurement)

The determination of interior egg quality was done by the objective method which includes the measurements carried out using instruments.

The Egg White Quality

The measurement of the egg white and thick albumen height was done by taking measurement between the outer thick white and the yolk using a micrometer. Such expression is known as Haugh unit formula which shows an increase in an egg weight and a decrease in HU of 18% dietary protein without affecting egg yolk, albumen and shell thickness.

$$HU = 100Log\,\frac{(H-\sqrt{G(30\,W^{0.75}-100)+1.9}}{100}$$

Where, H = albumen height in mm
G = 32.2
W = Weight

The higher the HU the better the egg white quality. Four types of white egg quality are found according to the United States Department of Agriculture (USDA), and they are:

- AA = >72 HU
- A = 60 – 72 HU
- B = 31 – 60 HU
- C = 31 HU

Albumen and yolk indices

The standard quality of albumen and yolk is measured by micrometer or vernier caliper for height or average. The indices are obtained by dividing the height by the average width.

$$\text{Yolk Index} = \frac{height\ of\ yolk}{\text{Average width}}$$

The normal value for fresh egg range between 0.40 –0.42, as the yolk becomes flattened the yolk index lowered.

The albumen index is the measurement of albumen and measured as follows:

$$A.I = \frac{H-30(W^{0.37}-100)}{\sqrt{G}}$$

Where, H = height of albumen in mm.
G = 32.2
W = Weight of albumen in g.
A.I = Albumen index.

According to USAD egg weighing 56.7gm is considered as grade AA. The experimental equipment used include :

(i) Vernier for measuring length and width of egg as well as yolk length, width and albumen height,
(ii) Sensitive balance for egg weight,
(iii) Containers containing water solution of sodium chloride in different concentration for measuring the specific gravity of the eggs, and
(iv) Petridishes for collecting broken eggs and separating the yolk from albumen.

Statistical Analysis

The data obtained were managed and evaluated using statistical analysis system (SAS) software. The means and other descriptive statistics were analyzed using ANOVA, one way analysis of variance and significant means were separated using multiple range test.

RESULTS

Table 2, expresses the physical characteristics/ traits of the egg in both exotic and indigenous breeds with their respective different (P-value). Results for the egg weight, length, width, shape index, specific gravity, yolk index, albumen height and shell thickness showed a high significant difference ($P \leq 0.0001$) between the exotic and indigenous poultry breeds. The result for the egg yolk length showed a significant difference ($P \leq 0.001$) between the exotic and indigenous breeds. While result for the yolk width showed the least significant difference ($P \leq 0.05$) between the exotic and indigenous breeds for the egg yolk width trait.

Table 2: A Comparative Study of Egg quality Characteristics of Exotic and Indigenous Poultry Breeds.

S/No	Variable	Exotic Breed		Indigenous Breed		P-Value	LS
		X ±SE	SD	X± SE	SD		
1	Egg Weight	56.041±0.776	3.881	23.501±1.991	7.252	≤0.0001	* * *
2	Egg Length	5.722±0.042	0.208	4.976±0.069	0.201	≤0.0001	* * *
3	Egg Width	4.092±0.022	0.108	3.539±0.040	0.201	≤0.0001	* * *
4	Egg Shape Index	96.371±0.261	1.304	98.203±0.258	1.201	≤0.0001	* * *
5	Egg Specific Gravity	1.038±0.006	0.029	0.956±0.012	0.592	≤0.0001	* * *
6	Egg Yolk Length	3.313±0.055	0.277	3.093±0.054	0.271	0.0066	* *
7	Egg Yolk Width	2.968±0.034	0.163	2.70±0.042	0.210	0.0397	*
8	Egg Yolk Index	1.038±0.008	0.022	1.063±0.011	0.055	≤0.0001	* * *
9	Egg Albumin Height	3.969±0.022	0.108	3.308±0.039	0.196	≤0.0001	* * *
10	Egg Shell Thickness	0.313±0.003	0.014	0.280±0.004	0.020	≤0.0001	* * *

X = Mean, SE = Standard Error, SD = Standard Deviation,
P-Value = Probability value, L.S = Level of Significance,
* = Least Significant (P≤0.05), ** = Significant (P≤0.001),
*** = Highly Significant (P≤0.0001),

Discussion

As shown in table (2), the means for the studied parameters; egg weight, egg length, egg width, egg shape index, egg specific gravity, egg yolk length, egg yolk width, egg albumen height, egg shell thickness showed highly significant differences. Whereas egg yolk length showed a significant difference and egg yolk width had the least significant difference. The difference in egg weight could be attributed to either age of the birds and/or genetic makeup of the two birds. Lukas *et al.,* (2008) reported that egg weight increased as layer's age advanced. However, Moula *et al.,* (2010), Zaman(2003) and Ketelaere *et al.,* (2002), found significant differences in egg weight being affected by genetic makeup and the heaviest eggs were produced by the commercial strains (Moula *et al*., 2010 Parmar *et al*., 2006). This difference obviously resulted from the selection process undergone by commercial strains for egg weight (Moula *et al.,* 2009).

Egg length, egg width and egg shape index were highly significantly different in the two birds. Egg length and width partially depend upon other parameters such as egg weight (Al-Rubaiee, 2012), and the lower egg shape index of exotic breed is the result of the fact that, egg shape is the ratio of the width to length of the egg. Brand *et al.,* (2004) reported that shape index of the eggs decrease with age because shape index is directly proportional to egg width, and it is inversely related to egg length, which implies that with increasing age, the rate at which eggs become longer is faster than the rate of becoming wider.

There was a high significant difference in egg specific gravity between the two breeds. Egg from the exotic breed had a higher specific gravity compared to indigenous breed, indicating a better shell quality. Bennett (1992) reported that eggs with specific gravity less than 1.00 had poor hatch and increased embryo mortality.

Egg yolk length and egg yolk width showed no highly significantly difference between the two breeds. The differences obtained in these parameters could be due to differences in nutrition and genotypes. But the means of the yolk index in the two breeds were highly significantly different, and these could be attributed to differences in breeds, nutrition and storage of egg. There were significant differences in the yolk characteristics in various species of poultry and these differences were mainly caused by genetic variation, (Reidy *et al.,* 1994 Curtis *et al*., 1985). The mean of the yolk index in the indigenous breed was greater than the ones in the exotic breed, simply because the yolk index is the ratio of height of yolk to diameter of yolk.

The egg albumen height is greatly influenced by genetic factors with minor effects of nutrition on specific cases (Benabdeljelil and Jensen, 1990). Therefore, the highly significant difference in the albumen height between the two different breeds could be attributed to variations in their genotype.

The shell thickness varied significantly between the two breeds. The variation may be attributed to the feed composition utilized and age of the hens. As reported, egg shell quality declines as the age of the hen increases (Nys, 1986). Differences in shell thickness are determined by both genetic and non-genetic factors, the latter including the age of the layers and feeding (Dobrzanski *et al*., 2007). Shell strength was found to decrease with age, most probably due to decreasing availability of dietary calcium and phosphorus to layers and changes in shell structure (Rodrigez-Navarro *et al*., 2002).

Conclusion

This comparative study of egg quality traits of exotic and indigenous poultry breeds shows that the indigenous Baledy poultry breed is potential. Further study is needed for inclusion of other indigenous breeds for improving egg quality and hatchability in South Sudan.

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