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PROXIMATE COMPOSITION AND QUALITY CHARACTERISTICS OF DUCK EGGS AS INFLUENCED BY HAEMOGLOBIN TYPE

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ABSTRACT

Proximate, mineral composition and egg quality traits of 3 haemoglobin (Hb) types of Muscovy ducks were studied. Sixty eggs (20 per Hb type) from Hb (AA, AB and BB) of ducks were used. External egg qualities measured were: egg weight, egg length, egg width, shell weight, shell thickness and egg shape index while internal qualities included: albumen weight, albumen height, albumen width, albumen length, yolk weight, yolk height, yolk width, albumen index and yolk index. Data collected was subjected to one-way Analysis of Variance in a Completely Randomized Design using Statistix Analysis software version 10.0. Significant means were separated using Least Significant Difference (LSD). Mineral composition of the eggs was determined using AOAC method; crude protein by Kjeldahl method; ether extract by Soxhlet method. Result showed that Hb type significantly ($p<0.05$) influenced egg weights; Hb AA was highest and values ranged from 60.31 to71.55 g. Egg shape index ranged from 80.39 to 75.85%, and Hb AB was significantly higher than the other groups. Albumen weight, length and height, yolk weight, and yolk index were all significantly ($p<0.05$) affected by haemoglobin genotype of the ducks. Albumen weight ranged from 28.91 to 31.52 g while yolk weight ranged from 20.31 to 22.22 g, Hb AA was significantly higher in both respects. Mineral composition of the eggs was significantly ($p<0.05$) influenced by Hb genotype in Calcium, Zinc and Iron contents. Values recorded were 0.16 to 0.22 %; 4.42 to 7.23mg/g and 12.59 to 19.64 mg/g for calcium, zinc and iron respectively. Haemoglobin genotype Hb AB had significantly higher zinc and iron content while Hb BB eggs were significantly($p<0.05$) higher in calcium. Haemoglobin type significantly affected crude protein (CP), ether extract (EE), nitrogen free extract (NFE) and moisture contents of eggs. Values recorded were: 42 – 46.58 %, 34.33 – 37.08%, 18.08 – 20.68% and 70.50 – 72.22% for CP, EE, NFE and moisture contents, respectively. Ducks of Hb AA are recommended for improvement as egg type ducks whereas Hb BB and AB can be selectively improved for mineral and proximate content quality. Duck eggs, irrespective of Hb genotype, are good sources of quality protein to mitigate protein deficiency.

KEYWORDS: Eggs, Haemoglobin genotype, Muscovy duck, nutrition, poultry

INTRODUCTION:

Differences in genotype account for most of the variability in the reproductive and performance capacities of animals individually and at breed levels (Dauda and Ebegbulem, 2023). The ability to distinguish these variabilities could be a basis for selection for sequential genetic improvement of farm animals. Polymorphism is said to occur in a population when two or more markedly inherited varieties co-exist in the same individual (Das et al., 2008). Akpa et al. (2011) asserted that it is possible to use polymorphisms that exist among proteins to map various gene types such as disease- causing genes, economically important trait genes, and for selection of superior breeding animals. Genetic diversity within a population's gene pool can be studied by electrophoretic analysis to decipher variations in these proteins (Rege and Okeyo, 2006).

Three types of Hb have been observed in poultry which are controlled by two autosomal alleles A1 and A2 (Yakubu and Aya, 2012;

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Oguntunji and Ayorinde, 2015; Ebegbulem and Ekwere, 2021). Selective advantages due to different Hb types have been reported. Such advantages include helminthic infestation resistance (Ndamukong, 1995), effect on meat quality (Bezovo et al., 2007) and productive traits such as egg production (Boonprong et al., 2007).

Poultry eggs play significant role in the food industry as source of high-quality protein in human diet (Ebegbulem and David, 2021). Eggs are rich in amino acids, carbohydrates, vitamins, minerals and soluble fats (Ahmad et al. (2017). Duck eggs are consumed for the high nutritional attributes including composition of essential amino acids, fatty acids with a high percentage of polyunsaturated fatty acids; they also have a favourable ratio of omega 6- to omega 3-fatty acids (Al-Obaidi and Al-Shadeedi, 2016).

Quality may be defined as the inherent properties of a product that determines its degree of excellence; those conditions and characteristics that consumers want and are willing to pay for, are considered as factors of quality (Hauver and Hamana, 2000). Egg quality is described on the basis of interior and exterior characteristics in addition to their nutrient content (Ebegbulem and Asukwo, 2018).

Egg quality is an important economic index in the egg industry. Egg quality also affect the hatchability of incubated eggs and on duckling weight and development. Therefore, the attainment of success in any poultry business depends on the number of good quality eggs produced. In addition to environmental factors, genetic influences like breed and genotype have been noted to impact on egg quality characteristics (Wijedasa et al., 2020). These quality traits can therefore be improved through knowledge of their genetic and phenotypic differences. This study was therefore designed to determine the proximate and mineral composition as well as egg quality traits of the different haemoglobin (Hb) types of Muscovy ducks in Calabar, Cross River State.

MATERIALS AND METHODS:

The research was conducted at the Poultry Unit of the Teaching and Research Farm, University of Calabar, Nigeria. Calabar is located at latitude 4° 57´32.15´´N and longitude 8°19´37.02´´E (Tageo, 2024). Egg mineral and proximate composition was analyzed at the Faculty of Agriculture Central Laboratory, University of Calabar. A total of 60 (20 per Hb group) fresh eggs were collected from three haemoglobin groups of ducks at four (4) weeks in lay and used for egg quality parameters determination. Fifteen (15) egg samples were used for the proximate and mineral sample parameters, five (5) eggs per haemoglobin types (AA, AB, BB). External egg qualities measured were: egg weight, egg length, egg width, shell weight, shell thickness and egg shape index while internal qualities included: albumen weight, albumen height, albumen width, albumen length, yolk weight, yolk height, yolk width, albumen index and yolk index as described by Ebegbulem and Asukwo (2018).

The mineral elements were determined using 2 g of samples digested in perchloric and concentrated nitric acid, diluted with deionized water in a 50 ml volumetric flask. Phosphorus (P)
(colorimetric method), Sodium (Na), Magnesium (Mg), calcium (Ca), Iron (Fe), Zinc (Zn) and Potassium (K) concentrations in the digest were estimated using the Perkin Elmer Atomic absorption spectrophotometer (AOAC 2005).

The moisture content of each whole egg sample was determined according to AOAC procedure (2005). Samples were kept in an oven at 100°C for 45 - 60 min, until when dried and then weighed. It returned into the oven and reweighed after 2 hours to ensure a constant weight. Protein content was determined by kjeldahl method (AOAC, 2005) and values obtained multiplied by the constant 6.25 to calculate crude protein percentages. Crude fat was determined by ether extract method using Soxhlet apparatus. The crude fat or ether extract (EE) procedure estimates the quantity of lipids. To perform the procedure, the dried samples were ground and extracted with an organic solvent for about 2 hours and the remaining residue were dried at 103°C and weighed. Ether extract was calculated as the difference between the original sample and the ether extract residue. Ash content was determined by placing 2.0 g ground whole egg in a crucible which was transferred into a furnace set to 550°C, then the sample was incinerated in the furnace for 8 hours and the crucible containing the ash was removed and cooled in the desiccators and weighed. The weight of the residue in the crucible corresponds to the ash content of each egg sample. Crude fibre content was also determined using the Weende method (AOAC method 978.10) (AOAC, 2005).

The nitrogen free extract determination was calculated using the following formula: % NFE = 100 % – (% EE + % CP + % Ash + % CF).

Statistical analysis:

Data collected were subjected to the one-way analysis of variance (ANOVA) using statistix analysis software version 10.0 (2013) employing the completely randomized design. Means were separated using Least Significant Difference (LSD) at $p<0.05$.

RESULTS AND DISCUSSION

External egg qualities

Table 1 shows result of the external egg qualities of ducks with the different heamoglobin types. Egg weight (EW) and egg shape index (ESI) were significantly ($p<0.05$) different between heamoglobin types. Hb AA had the highest egg weight (71.55g) while Hb AB and BB were statistically similar. However, egg shape index for Hb AB was significantly ($p<0.05$) higher than those of Hb AA and BB. Egg weight values in the present study varied slightly with the report of Etuk et al. (2012) who recorded values of

70.80, 76.27 and 76.35 g for Muscovy ducks reared semi- intensively, intensively with wallow and intensively without wallow, respectively. The EW value recorded for Hb AA was consistent with the 69.50g reported by Garba et al. (2016) in Muscovy ducks reared in Sokoto State Nigeria. Egg weight value for Hb AA in the present study however was higher than 56.22g reported by Ahmad et al. (2017) in Bangladeshi native ducks. However, the values obtained for Hb AB and BB (60.31 and 61.52 g respectively) were similar to 63.39g reported in farm Bangladeshi ducks by Ahmad et al. (2017).

Differences between the results of the present research and previous authors report could be attributed to differences in nutrition, management systems, breed and geographical location. Egg weight is an important economic determinant of value a consumer is willing to pay for an egg. The Hb AA is advocated for selection and improvement as egg type ducks. The value for egg shape index were within the range (74 – 76%) reported by Etuk et al. (2012); Al-Obaidi and Al-Shadeedi (2016); but higher than 52.25% obtained by Garba et al. (2016). Egg shape index is important in the egg industry as a good shape index guarantees ease of fitting into incubator hatching trays as well as egg trays for transportation, avoiding cracks and economic losses to the farmer (Onunkwo and Okoro, 2015).

Table 1: External egg quality characteristics of haemoglobin types of Muscovy ducks

Parameters	**Haemoglobin Type**				
	AA	**AB**	**BB**	**SEM**	**Sig.**
Egg weight (g)	71.55^a	60.31^b	61.52^b	0.71	*
Egg length (cm)	6.07	5.48	5.67	0.07	
Egg width (cm)	4.59	4.39	4.37	0.03	
Shell weight (cm)	9.97	9.26	9.26	0.16	
Shell thickness (cm)	0.1	0.1	0.1		
Egg shape index (%)	75.62^b	80.12^a	77.07^b	1.22	*

* Significance ($p<0.05$) SEM= Standard error of mean

Internal egg characteristics

Table 2 shows the result of the internal egg qualities of the ducks. Albumen weight, length and height, yolk weight, yolk index and albumen index were statistically significant ($p<0.05$) among the Hb groups, while albumen width, yolk width and height were not statistically ($p>0.05$) different. Albumen weight ranged from 28.91 – 31.52g and ducks with Hb AA had the highest value. Nuhu et al. (2018) reported similar value (31.50g) but Rahman et al. (2010), Amao and Olugbemiga (2016) and Garba et al. (2016) indicated lower values of 24.57 – 28.78g. Nayak and Mohanty (2013), Garba et al. (2016), Congjiao et al. (2019) and Purwantini et al. (2021) reported values (32.27 – 45.12g) higher than those obtained in the present study.

Significantly ($p<0.05$) higher albumen weight and yolk weight were exhibited by ducks with Hb AA egg type corresponding to the group with higher egg weight and circumference.

Table 2: Internal egg quality characteristics of haemoglobin types of ducks

Parameters	Haemoglobin Type				
	AA	AB	BB	SEM	Sig
Albumen weight (g)	31.52^a	28.91^b	30.31^a	0.67	*
Albumen length (cm)	9.18^a	7.45^c	8.56^b	0.16	*
Albumen width (cm)	5.29	5.11	5.57	0.11	
Albumen height (cm)	0.73^b	0.84^a	0.70^b	0.03	
Yolk weight (g)	30.31^a	22.22^b	22.38^b	0.66	*
Yolk width (cm)	4.41	4.21	4.32	0.05	
Yolk height (cm)	1.98	2.03	2.03	0.04	
Yolk index (%)	44.89^b	47.51^a	46.99^a	0.9	*
Albumen index (%)	13.79^b	16.70^a	12.62^b	0.65	*

* Significance (p<0.05) SEM= Standard error of mean

^{abc} Means on same row with different superscripts are statistically different

Table 3 showed significant (p<0.05) differences between the three hemoglobin groups for calcium, zinc and iron contents, whereas magnesium, potassium, sodium and phosphorus contents did not differ between groups. Haemoglobin type BB eggs had higher (p<0.05) calcium and zinc minerals suggesting that Hb BB ducks may be selectively improved for their high calcium content. Calcium mineral is important for proper bone formation in growing humans it is therefore recommended that duck eggs obtained from the Hb BB genotype be included in diets of children and pregnant women (Al-Obaidi and Al-Shadeedi, 2016). Ebegbulem and David (2021) reported calcium content of 22.20 mg/100g and 38.00mg/100g in the local chicken and guinea fowl eggs, respectively. The authors also recorded sodium values of 22.66mg/100g and 19.70mg/100g for chicken and guinea fowl eggs, respectively.

Table 3: Mineral composition of duck eggs according to their haemoglobin type

Parameter	Haemoglobin Type				
	AA	AB	BB	SEM	Sig
Calcium (%)	0.16^b	0.17^b	0.22^a	0.007	*
Magnesium (%)	0.09	0.09	0.09	0.005	
Potassium (%)	0.62	0.56	0.65	0.024	
Sodium (%)	0.04	0.04	0.03	0.009	
Phosphorus (%)	0.23	0.21	0.23	0.012	
Zinc (mg/g)	4.42^b	6.78^a	7.23^a	0.014	*
Iron (mg/g)	12.59^c	19.64^a	16.60^b	0.122	*

* Significance (p<0.05) SEM= Standard error of mean

^{abc} Means on same row with different superscripts are statistically different

Proximate composition

Result of the proximate composition of the three Hb groups of duck eggs is presented in Table 4.

The Crude protein content was significantly ($p<0.05$) higher in Hb BB eggs (46.58%) than Hb AB (43.08%) and Hb AA (42.00%). The CP content of eggs in the present study were higher than the values of 9.56% - 21.66% reported by Nayak and Mohanty (2013), Fakai et al. (2015), Al-Obaidi and Al-Shadeedi et al. (2016) and Ahmad et al. (2017) for duck eggs. High crude protein content of eggs of the different Hb types implies that the eggs can serve as veritable sources of protein in human diet and the Hb AA is recommended as a good protein source due to its higher protein content. Fakai et al. (2015) asserted that proteins are essential components of living cell and needed for human body growth and maintenance of body cells.

Ether extract ranged from 34.33% - 37.08% with Hb AB having the highest value. These values are higher than those (9.59- 14.15%) reported by Nayak and Mohanty (2013), Fakai et al. (2015), Al-Obaidi and Al-Shadeedi et al. (2016) and Ahmad et al. (2017). Ash content of 1.0 % was found in all three Hb groups which was slightly lower than value from the findings of Ahmad et al. (2017) and Nayak and Mohanty (2013) on Native duck eggs. Fakai et al. (2015) and Al-Obaidi and Al-Shadeedi et al. (2016) reported values ranging from 1.12 - 1.83% which are relatively higher than the values obtained in this present research. Differences between findings of the present study and previous researches could be attributed to differences in location, chemical analyses and nutrition of the birds.

Nitrogen free extract content between eggs of the haemoglobin types were significantly ($p<0.05$) different, Hb AA had higher (20.68%) content compared to the other two groups.

Moisture content ranged from 70.50 to 72.22%. Similar findings ranging from 68.66 - 71.83% have been reported by Fakai et al. (2015), and Ahmad et al. (2017). The level of moisture content indicates level of freshness of the egg, therefore high moisture content obtained in this research are testament to their freshness and optimum quality.

Table 4: Proximate composition of duck eggs according to their haemoglobin type

Parameter (%)	Haemoglobin type				
	AA	AB	BB	SEM	Sig
Crude protein	42.00^b	43.08^b	46.58^a	0.340	*
Ether extract	36.48^a	37.08^a	34.33^b	0.269	*
Crude fibre	0.00	0.00	0.00	0.000	
Ash	1.00	1.00	1.00	0.000	
NFE	20.68^a	18.83^b	18.08^b	0.561	*
Moisture content	70.50^b	72.22^a	72.00^a	0.251	*

* Significance ($p<0.05$) SEM= Standard error of mean

NFE= Nitrogen free extract

^{abc} Means on same row with different superscripts are statistically different

CONCLUSION

From the results it can be concluded that;

1. Ducks of Hb AA type had significantly ($p<0.05$) higher egg yolk and albumen weights, therefore, are recommended for selection and improvement as egg type birds.
2. Due to their higher crude protein, calcium and zinc contents, duck eggs of Hb BB type can be selectively improved for crude protein, an important factor that ameliorates protein deficiency in human nutrition.

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