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Research Article
Variations in Morphometric Traits of Muscovy Ducks Measured at PNGUNRE Poultry Farm

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Abstract

Background and Objectives: Morphometric traits play important role in the selection and breeding programs for genetic improvement of Muscovy ducks. The objective of the current study was to measure variations in some morphometric traits using the plumage colors of Muscovy duck population under farm conditions. **Materials and Methods:** This study was conducted at the poultry unit of PNG-UNRE farm using 38 randomly mated adult Muscovy ducks. Four phenotypes (plumage colors); [Chocolate (n = 7), Lavender, (n = 5), Silver (n = 7) and White (n = 19)] were measured. Copra meal was fed to birds daily and allowed to scavenge during the day within the fenced farm. Means and standard deviations of all measured traits were computed. **Results:** White phenotype was dominant among Muscovy duck population under farm conditions. The highest body weight (BW = 1875.71±243.64 g) and body size (BS = 30.86±1.57 cm) was observed in silver colour. The highest shank length (SL = 4.86±0,69 cm), body height (BH = 12.80±1.30 cm) and body length (BL = 12.80±1.30 cm) was observed in Lavender colour; while the highest beak length (B^kL = 4.86±0.69 cm) and neck length (NL = 14.00±0.82 cm) was observed in Chocolate colour. **Conclusion:** The existing variations in traits among species and individuals are commonly observed situation in genetics across all species of livestock. Despite existing variations, silver phenotype has the highest body weight (BW= 1875.71±243.64 g) and body size (BS = 30.86±1.57 cm). Body weight is a vital economic trait which should be considered for selection and genetic improvement.

Key words: Muscovy duck, plumage colors, morphometric traits, economic traits, phenotypic diversity

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Among domesticated avian species Muscovy duck is ranked third with an estimated population of 9,553,911 after chicken (101,676,710) and guinea fowl (16,976,907)[1]. Muscovy duck (*Cairina moschata*) and common duck (*Anas platyrhynchos*) popularly known as local and exotic ducks are the most common genera of ducks reared. Muscovy duck is commonly found all over the world[1,2]; constituting 74% of all duck species. Muscovy duck is an integral part of local poultry sector on a small scale in the rural areas .

Information on genetic attributes of the species is very vital to its conservation, characterization, improvement and efficient utilization. Genetic characterization based on molecular assessment had been reported to be the most common method to evaluate genetic diversity between and within livestock breeds but it needs high technology and cost[3]. Because of that, researchers also use other methods based on morphological characteristics which are easy to monitor and provide a reliable information on genetic diversity at low-cost.

The concept of size and shape are fundamental for the analysis of variation in living organisms. Parting biometrical variations in into size and shape components are often highly desirable. The size of most organisms is more affected than shape by fluctuation of the external environment[4]. The current study investigated the effect of phenotype on morphometric variations in Muscovy ducks. Variations in the morphometric traits assist in selection and breeding programs for genetic improvement of Muscovy ducks. No previous studies have been carried out on its commercial production and comprehensive characterization research. Therefore, the present study was carried out to investigate the phenotypic, genetic, morphological, biochemical and immunological characteristics of Muscovy ducks[5].

Breeds of Muscovy ducks: Muscovy duck is a species of waterfowl native to South America, Central America, Mexico and a small portion of southern Texas in the United States[6] meaning it's an introduced species to PNG (PNGUNRE farm). However, they have a high reproductive potential[7]. Although they were domesticated hundreds of years ago, even though they have been getting increased attention from backyard homesteaders.

Muscovy ducks and other fowl breeds are divided into three categories; meat, eggs and dual-purpose breeds. Duck breeds, for meat and egg production, can be of local or improved strains. Local duck breeds are often kept for dual-purpose, while improved breeds are mostly bred for single purpose (meat or eggs).

Yakubu[8] stated that Muscovy duck is the heaviest bird in the rainforest ecology weighing 2.2±0.05 kg while 2.0 kg±0.05 kg was recorded for savannah ecology.

Yakubu[8] further described variations in plumage colors stating that the mean body weight for the plumage colors; multicolor, black, white and black and white were, 2.64, 2.05, 2.12 and 1.92 kg respectively.

These breeds are usually not described in detail. According to Bati *et al.*[9] out of more than 150 genera of water fowl, common fowl and Muscovy ducks are two common species mostly reared in the farm back yards. In India two strains were classified as white and black Muscovy ducks, however, information on duck strain is still lacking.

The specific characteristics of these duck breeds are unknown in many parts of the world including Papua New Guinea. Thus, more research for the genetic diversity is paramount in terms of germ plasm, conservation of desirable traits and food security reasons in the future. Bati *et al.*[9] reported that more research is now underway to develop new strains of Muscovy ducks in India.

Economic importance of ducks: Duck meat production increased from 1.3 million tons in 1991 to 3.6 million tons in 2007[10] with 65% of the world production coming from China. Duck production in 2010 was six-fold that of 1961. In Nigeria, the duck population is ranked third (9,553,911) after chicken (101,676,710) and guinea fowl (16,976,907). Muscovy ducks make up about 74% of the ducks in Nigeria and its meat is lower in fat and hence considered to be healthier[11]. Adesope and Nodu[11] reported that increased duck rearing would be a great addition to total poultry output since they do not interfere with chicken production due to different rearing and scavenging venues.

The market chain analysis showed that self-sufficient farms mostly do not sell their products outside the commune. Intermediate sub-systems sell their products directly to retailers (shops) or to end consumers (customers and hatcheries). Semi-commercial farms sell their products to retailers and end consumers, as well as middlemen. The higher the specialization grade is, the more complicated the marketing constellation becomes (various stakeholders and marketing steps are involved). By-products such as feathers are usually kept for the own use on self-sufficient farms and sold to traders by intermediate or semi-commercial farms.

The Muscovy duck has few of the problems associated with the Pekin species, with some added benefits and

considered as a favorable alternative of the Pekin Duck. Most people prefer to raise Muscovy ducks due to their ample and succulent breast meat; many people like filet mignon[12].

Muscovy duck production can transform the life of the local farmer through adequate management and available resources. Muscovy duck is a water fowl, disease resistant, has better growth percentage, high quality meat, low fat and savory flavor and utilize low-quality feed despite low egg production[13].

MATERIALS AND METHODS

Location of research: The research was carried out at PNG UNRE Poultry farm, Vudal (latitude: -4.3512°South, longitude: 152.0075° East). Geographically, the experimental site is in a tropical climate, with a large amount of rainfall even in the driest month. The rainfall is around 1987 mm to 78.2 inch per year. Average annual temperature is 27.0 to 80.6°C. Fig. 1 shows the site map of PNGUNRE Farm.

Appearance and description of Muscovy ducks: Thirty-eight Muscovy ducks of laying age group of the four genotypes (Chocolate n = 7, Lavender n = 5, Silver n = 7 and White n = 19) were used in the experiment. The parameters measured in this study were; plumage color, beak length, shank length, body height, body length, body weight, body size and neck length. Each bird was measured and tagged with colored wool to avoid repeated measurements. The body weight was measured in grams using a digital scale (5 kg capacity) while other six traits were measured in centimeters using tailoring tape. Visual observation was made to identify the plumage colors for consecutive measurements.

Measured Traits	Descriptions
Body weight (BW)	Individual body weight of ducks was measured using a Balance scale (5kg Capacity). The duck legs were tied and placed into the bucket. Bucket weight was tarred and initial reading for the scales was taken and recorded[14].
Body height (BH)	The body height was measured using a sawing tape having the bird stand at a horizontal position from the feet stage. The measurement was taken from the tip of the duck's head to the feet to get the reading[15].
Neck length (NL)	This was measured as the distance between the first and the last cervical vertebra and the pygostyle[15].
Body size (BS)	Measured under the wing through the anterior border of the breast bone crest and the central thoracic vertebrae.
Body length (BL)	Body length was measured as distance between the base of the neck and that of caudal end[15].
Shank length (SL)	Shank length was measured as distance from the shank joint to the extremity of the *digitus pedis*.
Beak length (B^kL)	This was measured from the brooder end of the beak (towards the head) to its pointed end

Fig. 1: PNGUNRE farm project site map (Google map generated by Leoni Worowan)

All Muscovy ducks have long claws on their feet and a wide flat tail. The length of male duck is about 86 cm and weighs is 10-15 kg, while the female is much smaller, at 64 cm in length and about 6-8 kg in weight. The wild Muscovy duck is mostly black, with large white wing patches. Domesticated birds may look similar; most are dark brown or black mixed with white, particularly on the head. Other colors such as lavender or all-white are also seen. Both sexes have a bare black-and-red or all-red face[13]. They had a fleshy outgrowth which are red in color and are found around the eyes and beaks. They are found mostly along the coastal areas of southern Nigeria[15]. These ducks have large variations in phenotypic and biochemical characteristics which has a potential for genetic improvement . Live weight of drakes is 2.73 kg and a dressing percentage is 71.2% whereas live weight of ducks is 1.52 kg and a dressing percentage is 69.8%. Ducks farmed under free range ecotype can lay 60-80 eggs on average per year while an individual duck can lay 100-125 eggs per year. Eggs of these ducks can weigh 72 g under improved management systems[8].

The average lifespan of a Muscovy duck is up to 20 years. Life span of 20 years may not be possible to reach in the wild due to high risk of predation. However, in a farming situation their lifespan is limited to the curling stage and they are reared for breeding purpose and meat or egg production[16].

Data analysis: Frequency distribution of the total population of Muscovy ducks was plotted using the bar charts in Spread sheet of WINDOWS 2010. The descriptive analysis (average and standard deviation) of each morphometric parameter was compared to the four phenotypes of Muscovy ducks. Mean and standard deviation were calculated using the formulae;

$$\mu = \sum_{N=i} x_i \frac{x_1 + x_2 + \ldots x_n}{N}$$

$$\sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{N}}$$

σ : Population standard deviation
N : Size of population
x_i : Each value from the population
μ : Population mean

The multifactorial analyses was used to assess variation within a population and distinguish different population types when all measured morphological traits were considered simultaneously[17]. While discriminant analysis is one of the multivariate techniques commonly used for analyzing many variables (data) simultaneously. Researchers have employed this multivariate analysis technique extensively for careful selection of livestock species in various breeds and ecotypes[17]. An attempt has been made to evaluate size and shape of Muscovy duck at adult age[18], using principal component analysis. Since size, shape and the phenotypic variation between and within sexes change with age[19], the need to assess these attributes for selection and improvement is required. The focus of this study was to evaluate diversity of the existing population of Muscovy ducks for appropriate selection and breeding to genetically improve and characterize high performers.

RESULTS AND DISCUSSION

Phenotypic distribution: The highest phenotypic frequency for Muscovy ducks at PNG UNRE farm was white (Fig 2). The relative distribution of phenotypes (Chocolate, Lavender, Silver and White)[20] might be attributed to social preference. Ikeobi *et al.*[20] corroborated this assertion and reported that social preference in addition to natural selection and adaptation is the major cause of the variation in plumage color. The large proportion of Muscovy ducks was observed in the present study. This result agrees with the findings of Raji *et al.*[12]; Oguntunji and Ayorinde[21] who reported that in Nigeria white Muscovy ducks were approximately one-third of the populations. Ogutinji and Ayorinde[5] observed that, in Nigerian Muscovy ducks, white (88%) was the highest plumage color in a sampled population of 1020 adult and ducks. In contrast, in another study, Ogutinji and Ayorinde[1] observed small proportion of white-plumaged Muscovy ducks in North West of Nigeria. In addition, Dana *et al.*[22]. stated that plumage and skin colors are connected to cultural and religious beliefs. It is also postulated that plumage coloration is the mean of camouflage[23] that might be another factor responsible for low frequency of white-plumage Muscovy ducks in the studied population. Similar results were reported by Ayeni *et al.*[23] who observed the exceptional-low frequency of white-plumage color in Muscovy ducks.

The exceptionally-low frequency of occurrence of black plumage color in Nigerian Muscovy ducks might be attributed to social preference and/or recessive(s) segregating allele(s). In addition, phenotypic diversity observed in the expression of traits indicated problems in selection[5].

Variations in quantitative traits: The mean and standard deviations of quantitative traits measured among Muscovy ducks is summarized in Table 1. Variation was observed for all quantitative traits measured, depicted by significant differences between means among four phenotypes. The highest shank length (5.2±0.45 cm), body height (12.80±1.30 cm) and body length (36.40±2.51 cm) was observed in Lavender, the highest beak length (4.86±0.69 cm) and neck length (14.00±0.82 cm) was observed in Chocolate while the highest body weight (1875.71±243.64 cm) and body size (30.86±1.57 cm) was observed in Silver. The lowest body weight (1637.86±252.91 g) and body height (11.29±1.25 cm) was observed in Chocolate, the lowest shank length (4.71±0.49 cm) was observed in Silver, the lowest body

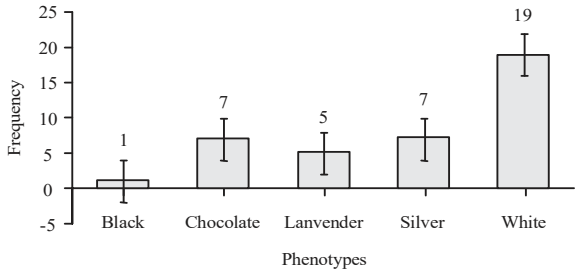

Fig. 2: Phenotypic distribution of Muscovy ducks at PNGUNRE poultry farm

Table 1: Results of quantitative Morphometric variables measured on the four phenotypes of Muscovy ducks at PNGUNRE poultry farm

Phenotypes	Genotype	Sex	Frequency	BW (g)	SL (cm)	BH (cm)	BL (cm)	B^kL (cm)	NL (cm)	BS (cm)
Chocolate	Cc	♀	n = 7	1637.86±252.91	4.86±0.69	11.29±1.25	33.00±2.31	4.86±0.69	14.00±0.82	30.14±3.02
Lavender	Ll	♀	n = 5	1780.40±143.74	5.20±0.45	12.80±1.30	36.40±2.51	4.80±0.45	13.60±1.52	29.60±1.82
Silver	Ss	♀	n = 7	1875.71±243.64	4.71±0.49	12.14±1.35	34.86±3.08	4.71±0.49	13.14±1.57	30.86±1.57
White	Ww	♀	n = 19	1747.37±2343.06	5.05±0.85	11.74±1.52	32.95±3.42	4.42±0.51	12.42±2.09	29.84±2.57

length (32.95±3.42 cm), beak length (4.42±0.51 cm) and neck length (12.42±2.09 cm) was observed in White while body size (29.60±1.82 cm) in Lavender.

It was observed that some traits were high while other traits were moderate or low in the same phenotype. For example; Silver phenotype has the highest BW and BS but was the second highest in BH and BL. The lowest ranked traits in Silver were SL, B^kL and NL. Egahi *et al.*[24] described the heterogeneity in the phenotypic traits and assumed that local village chickens may be considered for selection.

During independent assortment, varying values concerning dihybrid alleles segregate and deviate among species of livestock. Thus, the selection of targeted gene may become difficult if a recessive gene is detected in the interested population.

Results of the present study showed that the overall mean body weight for all phenotypes was higher compared to Body weight (kg) of Muscovy ducks in Nigeria[15]. Such variation provides an opportunity for future genetic improvement among and within duck populations. Quantitative traits such as body measurements are useful indicators to describe a breed or population along with qualitative traits and agro-ecological conditions the breeds inhabited.

The results of the current study agree with the findings of Daikwo *et al.*[25] who observed that selection of birds was mainly depend on physically observed traits like body size which determine the price of birds in village poultry markets. For Muscovy duck the main selected trait is the body weight (BW) as it is easy to measure and to select[21]. The results indicate that Silver is the desired plumage colour of Muscovy ducks that meets the requirements for genetic improvement.

CONCLUSION

Silver phenotype has the highest body weight (BW = 1875.71±243.64 g) and body size (BS = 30.86±1.57 cm). According to the current study, body weight is a vital economic trait which should be considered. Correlation between the BW and BS of Silver phenotype should be considered for appropriate selection and breeding.

The current investigation showed none of the phenotypes of Muscovy ducks qualifies for all the highest quantity of traits measured. Highly measured traits were distributed among the phenotypes with certain degree of variations among the given phenotypes. It is assumed that, existing variations within the sampled population of Muscovy ducks was due to genetic and environmental effects. Phenotypic diversity may not equally represent the genetic structure of the current population because of semi-intensive management system that leads to random mating to influence the population size. Both phenotypic and genetic diversity should be considered together for appropriate utilization of Muscovy ducks. Variations in traits among species and individuals were observed across all species of livestock.

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