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Phenotypic analysis of underutilized poultry species in Kenya

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Abstract

Poultry are playing an increasingly important role in ensuring food security especially in developing countries. They are a source of dietary protein as well as a source of income. In Kenya, there is an overreliance on chicken to provide poultry products like meat and eggs. Other poultry species such as domestic ducks (*Carina moschata* and *Anas plathyrynchos*), geese (*Anser anser* and *Anser cygnoides*), pigeons (*Columba livia*) and turkey (*Meleagris gallopavo*), in this paper referred to as minor poultry, have not been adequately exploited. This study aimed to characterize the phenotypic traits of these minor poultry species. Quantitative parameters measured were live body weight and shank length, while the qualitative traits of shank colour and skin colour were observed and recorded. Data analysis was done using Excel spread sheets and R Core Version 3.1.2.

Geese showed no variation in the qualitative traits scored as all birds sampled had white skin and yellow shanks. Ducks on the other hand exhibited the largest variations in shank colour with six different colours being identified. Ninety-eight percent of the ducks sampled had pink skin colour whereas the remaining two percent were white. More than half of the number of turkeys (fifty-six percent) had white skin colour and almost three quarters (seventy-two percent) had pink shanks. The dominant phenotypes identified in the pigeons sampled were eighty-seven percent with pink skin colour and ninety-four percent with pink shank colour. Males exhibited higher body weights as compared to the females ($p \geq 0.05$) in these four species. Shank lengths were significantly longer in males than females ($p \geq 0.05$) in all the species except in geese. Results from this study could be used by the National Poultry Improvement Program to establish breeding and improvement programs for minor poultry species. These underutilized poultry species could play a greater role in improving nutrition and alleviating poverty in Kenya, particularly in the rural areas.

Key words: *diversity, ecotypes, emerging livestock, family poultry, indigenous poultry*

Introduction

Indigenous poultry populations reared using backyard production systems account for more than 80% of poultry in some developing countries (Conan et al 2012; Pym et al 2006). Women tend to be the main participants in poultry keeping with most rural families rearing one or more species (Guèye 2005). To rural populations, poultry are often the only source of animal protein and an invaluable source of income. In Kenya, poultry are reared mainly for egg and meat production. Of the 32 million birds estimated to be reared in the country, 98% are chicken (76% consisting of free range indigenous chicken while 22% are commercial layers and broilers). The remaining 2% comprises other poultry species such as duck, geese, turkey, pigeon, guinea fowl, quail and farmed ostrich, which are becoming increasingly important (Government of Kenya 2010). The indigenous chicken and local ecotypes of ducks, geese, turkey, pigeons and guinea fowl are mostly reared in mixed flocks by small scale farmers who use village production systems (Guèye 2000; FAO 2008). The poultry roam freely and scavenge for their food with no feed supplementation and farmers provide housing only during the night to protect them from predators. Village poultry are highly adapted to the local conditions where they live, which is essential to achieving a sustainable, low-input production system.

Phenotypic traits are sometimes linked to specific adaptations (FAO 2012). Morphological characterization of local ecotypes of minor poultry species is therefore important if we are to exploit them fully. Income from the sale of meat and the eggs from the minor poultry species could play a vital role in poverty alleviation for rural communities especially for women, the youth and under privileged groups (Adzitey and Adzitey 2011). Ecotypes possessing unique traits need to be

conserved as a reservoir for genetic materials for future breed improvements (FAO 2012). Rural poultry reared in backyard systems are rarely vaccinated (Spradbrow 2005) and may possess innate immunity to poultry diseases. Ommeh et al (2010) identified a SNP in the Mx gene of indigenous chicken that confers resistance to avian viral infections *in vitro*. It will be significant if any of the minor poultry reared under village production systems are found to have resistance to common chicken diseases.

As the Kenya poultry population estimates (GoK 2010) above indicate, there is a vast overreliance on chicken with the other poultry species being largely underutilized. Ducks (mainly Muscovy ducks), geese, pigeons and turkey are found in various parts of the country in small numbers for local meat consumption and also for ornamental purposes (FAO 2008). Most farmers keep these poultry as ornaments and their productivity is generally low due to poor husbandry (Ogada et al 2016). A study on the phenotypic traits of minor poultry could be the initial step toward reaping benefits from ducks, geese, pigeons and turkeys in this country.

Previous similar studies include that conducted by Panyako et al (2016) on the phenotypic traits of domestic and wild guinea fowls in Kenya. Djebbi et al (2014) studied the phenotypic traits of turkey in Tunisia. In India, Banerjee et al (2013) studied the morphological traits of ducks and geese. Bhowmik et al (2014) studied the morphometric measurements, productive and reproductive performance of Jalali Pigeons in Bangladesh. Moraa et al (2015) carried out a similar study on the phenotypic traits relevant to adaptation to hot environments in indigenous chicken while Aswani et al (2017) also characterized phenotypes associated with body growth and egg production in local chickens from three agro-climatic zones of Kenya. This is the first study in Kenya to look into characterizing the phenotypic traits of ducks, geese, pigeons and turkey. An initial countrywide survey was conducted amongst farmers and middlemen in over 20 counties including Nairobi, Uasin Gishu, Kiambu, Makueni and Kwale. Farmers visited were found to keep ducks, geese, pigeons and turkey in mixed flocks with chicken. Middlemen interviewed confirmed that interest in these minor poultry which fetch premium prices was growing rapidly. Poultry sampled for this study were from Western Kenya where more households were found to keep ducks, geese, pigeons, and turkey in addition to chicken. The findings on the phenotypic traits of Kenyan local ecotypes of ducks, geese, pigeons and turkey could facilitate the establishment breeding and improvement programs for these poultry. This would impact the livelihoods of rural families by improving nutrition and alleviating poverty.

Materials and methods

Study sites

This study was conducted between 2014-2016 in Siaya, Busia and Bungoma counties of Western Kenya. Siaya county lies between latitude 0° 26’ to 0° 18’ north and longitude 33° 58’ east and 34° 33’ west. Busia County lies between latitude 0º and 0º 45 north and longitude 34º 25 east. Bungoma County lies between latitude 0° 25’ and 0° 53’ north and longitude34° 21’ and 35° 04’ east. Western Kenya has two rainy seasons with average rainfall from 750mm-1800mm per annum. Average temperature ranges between 15-30°C. Total sampling of poultry owned by households was done rather than random sampling from their flock.

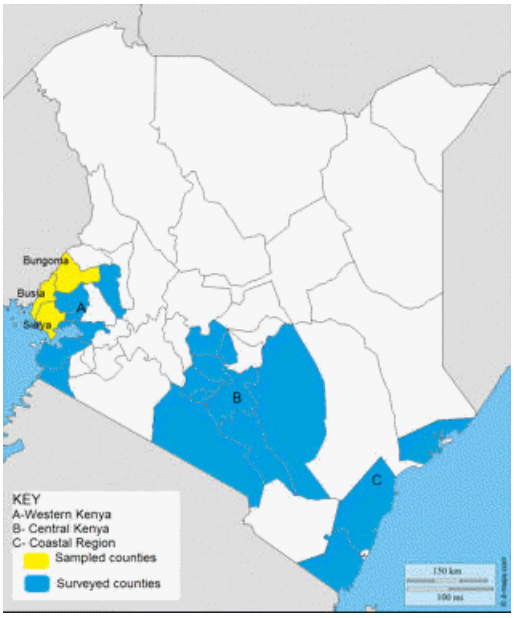

Figure 1. Map of study area (Source: http://d-maps.com/carte.php)

Study clearance

Permit of "No objection" number RES/POL/VOL.XXVII/162 was obtained from the Directorate of Veterinary Services, Ministry of Agriculture, Livestock and Fisheries in Kenya in order to conduct the study.

Data collection

A cross-sectional survey was conducted in villages within Siaya, Busia and Bungoma counties. Homesteads in the area were visited at random and only homesteads where domesticated ducks, geese, turkey and pigeons were found were considered for the study. From the chosen households, only farmers willing to participate were included in the survey. Interviews were conducted in collaboration with local agricultural extension officers to gain knowledge from the farmers on their experiences with rearing the minor poultry species. Sample numbers were chosen as per Hale et al (2012) because the same samples were part of a larger molecular study on minor poultry. A total of 136 poultry were sampled from the chosen homesteads based on the availability of the target species. The qualitative traits of skin colour and shank colour were identified through visual observation. The quantitative traits (body morphometric measurements) were taken once. Individual poultry were weighed using a scale and the body live weight recorded. Shank length, which is the distance from the upper most shank joint to the toe, was measured using a flexible measuring tape graduated in centimeters and a venier caliper graduated in millimeters. The Open Data Kit (ODK) application accessible on android mobile phones was used to record and store the data collected.

The sample numbers for the minor poultry species are shown in Table 1.

Table 1. Sample numbers for minor poultry

Species	Sample Number
Ducks	45
Geese	24
Pigeons	46
Turkey	21
Total	**136**

NB: *Sample numbers were chosen as per Hale et al (2012) because the same samples were part of a larger molecular study on minor poultry*

Data analysis

Data was analyzed using Microsoft Excel and ANOVA tests in R Core statistical software (R commander) version 3.1.2 to determine mean measurements of various quantitative traits in each population. Results are presented in the form of bar graphs, tables and percentages.

Results and discussion

Observed phenotypes

The four minor poultry species had diverse phenotypes that were noted during the survey as shown in Figure 2 below.

Figure 2. Observed phenotypes of turkey, pigeon, geese and duck.

Meleagris gallopavo (Turkey): A-White Holland, B-Royal Palm, C-Black
Columba livia (Pigeon): D-Rock Pigeon, E-Black/Grey, F-White
Anser anser (Geese): G-white feathered, H-Brown/Grey and White feathered, I-Brown feathered
Carina moschata (Muscovy duck): J-Black feathered, K-White feathered, L-Black and White feathered
NB: Feather colours of the ducks, geese and turkey indicated cross breeding.
The pigeons encountered were feral and thus could not be assigned to a specific breed.

Skin and shank colour

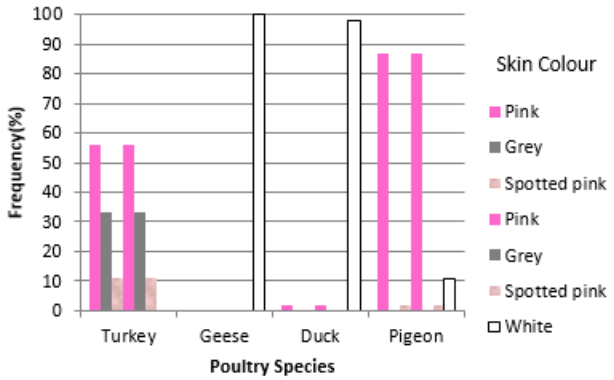

Figure 3. Skin colour distribution amongst the minor poultry species from Kenya

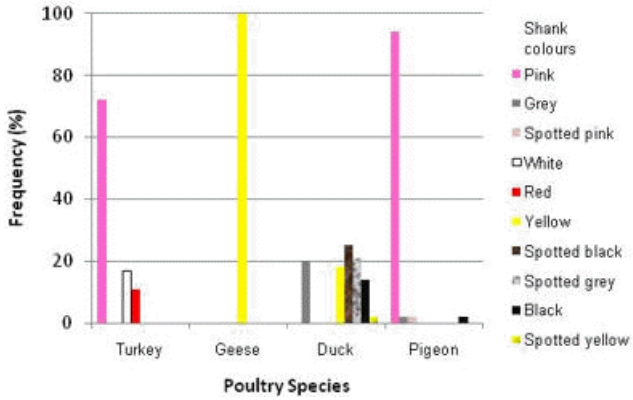

Figure 4. Shank colour distribution amongst minor poultry species in Kenya

We noted that sampled geese showed no variation in skin and shank colour. They all had white skin colour and yellow shank

colour. This is in partial agreement with Banerjee et al (2013) who reported white skin colour but both yellow and orange shanks in the geese sampled. The most common phenotypes were white, white with brown feathers and grey with some white feathers. All the geese were of the *Anser anser* species which are descendants of the graylag goose (FAO 2002; Albarella 2005). The white feathered geese are kept as ornamental birds and guardians in the homestead because they make noise when they spot strangers. Those with grey and brown feathers are kept for their meat.

We observed that the over half (56%) of the turkeys in the three counties had white skin colour with the red skin colour at 11%. The feather colours observed were white and black mixed with white as also reported of Mexican backyard turkey by Camacho-Escobar et al (2008).

The most prominent shank colour was pink (72%) and the least common was red (11%). The variations noted were fewer than those identified by Camacho-Escobar (2008) in Mexican turkey.

All the domestic ducks encountered in the study area were found to be Muscovy ducks (*Carina moschata*), which are known by their fleshy red outgrowths found around the eyes and beaks as described by Yakubu (2013). Muscovy ducks are characterized by black and white or Sepia coloured feathers. We noted all the ducks had white skin colour with one exception having pink skin colour. The shank colour in ducks showed the most variation with six different colours. Some of these variations in shank colour that have previously been reported are grey with yellow markings, plain grey and yellow as described by Banerjee et al (2013).

Pink was the predominant colour noted for the shank and skin colour of pigeons.87% had pink skin colour and 94% pink shank colour. The pigeons were feral and had a wide range of feather colours including white, grey, brown and black. Other than one Rock Pigeon, the pigeons could not be classified into exact breeds as the exhibited a mixture of characteristics due to cross breeding. This phenotypic diversity could also indicate genetic diversity which can be attributed to mating between the different breeds. A number of pigeon and dove species are found in Kenya including the Rock Pigeon (*Columba livia),*the Speckled Pigeon (*Columba guinea*), the Lemon dove (*Columba larvata*) , the Rameron/Olive Pigeon (*Columba arquatrix*) , the Delegorgues Pigeon (*Columba delegorguei*)) among others (Zimmerman et al 1999).

Shank length and body weight

Table 2 represents the measurements of body traits taken in Siaya, Bungoma and Busia counties.

Table 2. Interaction between body weight and shank length of the four poultry groups.

	Trait	Sex	Mean (Std. dev.)	P
Duck	Body weight (kg)	Female N=23	1.97 (0.40)	1.27e-11 ***
		Male N=22	3.38 (0.61)	
	Shank length (cm)	Female N=23	7.02 (0.46)	9.89e-10 ***
		Male N=22	8.42 (0.72)	
Geese	Body weight (kg)	Female N=12	3.27 (0.46)	0.0293 *
		Male N=12	3.73 (0.49)	
	Shank length (cm)	Female N=12	10.16 (0.61)	0.0517
		Male N=12	10.78 (0.83)	
Turkey	Body weight (kg)	Female N=9	3.39 (0.89)	4.55e-05 ***
		Male N=9	7.20 (1.86)	
	Shank length (cm)	Female N=9	13.5 (0.72)	3.18e-08 ***
		Male N=9	16.94 (0.72)	
Pigeons	Body weight (kg)	Female N=23	0.26 (0.04)	0.0391 *
		Male N=23	0.85 (0.03)	
	Shank length (cm)	Female N=23	3.51 (0.29)	0.0337 *
		Male N=23	3.70 (0.29)	

** Significant at 0.05, **Significant at 0.01 and *** Significant at 0.001.*
All the surveyed birds were adults over 12 months old.

We observed that mean body weight measurements (kg) were significantly higher in males than in females ($p \geq 0.05$) for all groups of poultry studied, with the largest difference between male and female body weight recorded in turkey. This provides evidence of sexual dimorphism, observations that are in agreement with Olver (1977). The average body weight of Muscovy ducks observed was higher compared to that observed by Banerjee et al (2013)and Omojola (2007), but lower than those reported by Yakubu(2013).The average body weight of the geese as assessed in the study is within the range reported by Sahin and Yardimci (2009).We also noted that males had longer mean shank lengths in all the four poultry species as compared to female shank length. Sex and body weight had significant interaction as shown in p values in the four types of poultry sampled with the highest interaction seen in turkeys.

Conclusion

- We found a significant correlation between sex and body weight as well as between sex and shank length in the minor poultry species.
- There is wide poultry species diversity across Kenya.
- Traders reported growing interest in ducks, turkey, geese and pigeon meat and eggs which are seen as delicacies and sell for good prices. Ducks, geese and turkey are larger than chicken providing larger quantities of meat per bird slaughtered.

Challenges

- Farmers often obtain eggs or poultry birds used to establish their flocks from other farmers and markets within their localities. This implies that the populations may not be very genetically diverse.
- Pigeons encountered were feral and could not be assigned specific breeds due to cross breeding between the different breeds.
- Many farmers keep ducks, geese, pigeons and turkey as ornaments and therefore no improvements are undertaken to increase productivity.
- The farmers reported many incidences of theft of geese and turkey which sell for good prices.

Recommendations

- Farmers are encouraged to source for birds to be used for breeding from other locations so as to ensure genetic diversity is not lost.
- Studies to investigate differences in phenotypic traits of the minor poultry according to the agro-climatic zones need to be carried out so as to establish whether the phenotypic traits observed are adaptations to their various environments.

Opportunities available

- Breeding programs could be set up to exploit advantageous traits of the minor poultry species such as disease resistance and low-maintenance costs.
- Genetic improvements could be used to increase productivity for meat and eggs.
- Rearing of minor poultry especially by women and the youth could be used as an avenue for poverty alleviation and wealth creation especially in rural areas.

Acknowledgements

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