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Performance Characteristics of Pigeons (*Columba livia domestica*) Reared Under Deep Litter System in Ghana

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Abstract

This study was conducted to assess the performance characteristics of the domestic pigeon reared under deep litter system in Ghana. For performance traits measurement, 50 local pigeons were raised intensively over a period of 5 months. In all, 25 males and 25 females were used. The birds were housed for 5 months in a deep litter house using the intensive system. Broiler diet was used to feed pigeons in this study. Data on the following performance traits were collected: egg characteristics (egg weight, egg length, egg width and shape index), fertility of eggs, hatchability, incubation period, squab weekly body weight and mortality (adult pigeons and squab) over the 5-months period. Performance characteristics were calculated using descriptive statistics of SPSS. Pearson's Correlation in SPSS was used to estimate correlation coefficients among the various external egg measurement. Results showed that pigeons laid two (2) eggs in every session of their incubation. The mean egg weight, length and width were 26.35 g, 3.68 cm and 2.87 cm respectively, with shape index of 78.095. Fertility rate and hatchability were 70.4 and 35.2% respectively. Mean squab weight at hatch was 22.655 g which increased steadily to 271.66 g by the 4th week. Squab mean body weight for day-1 was 22.655 g, and weekly averages from week-1 to week-4 were, 157.321, 224.107, 267.381 and 271.667 g respectively. Young male and female domestic pigeons were characterized by faster growth rate which slows down with age from day-1 up to the 4th week of age. Overall weight gains for male pigeons were 255.16 g and female pigeons were 242.86 g. The highest correlation for egg characteristics was between egg weight and egg length (0.847). Egg width correlates strongly positively with egg length (0.702). There was significant correlation between egg weight and egg length, and that of egg weight and egg width. It was concluded that pigeons are highly prolific, fast growth, short hatching period (16–17 days) and lay very few eggs per clutch.

Keywords: Squab weight, hatchability, pigeon fertility, mortality, egg characteristics

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INTRODUCTION

The term Animal Genetic Resources (AnGR) refers to all animal species, breeds and strains that are of socio-economic, scientific and cultural interest to humankind, providing food and agricultural production to sustain the present generation or the future generation or both [1]. AnGR are of great importance to every nation since they serve as an important source of income, employment and food. About 1.96 billion people basically depend on livestock to meet part or all their daily needs [2]. Many of the rural poor farmers in the world (about 70%) keep livestock and depend on the livestock as key part of their livelihoods [2]. Livestock also play an important role in

maintenance of ecosystems in which they exist, providing services such as dispersal of seed and nutrient recycling [3, 4].

The poultry industry is very economical in terms of land requirement, and can be operated in areas with inadequate land for large-land demanding meat-producing livestock [5]. The protein needs of the poorest people in society can be met with the help of rural poultry enterprise. The family-based rural poultry systems, which usually thrive well in the extensive management, continue to play a major role in sustaining livelihoods in developing countries. They supply poultry products not only in the rural areas but also peri urban and urban areas. They also provide important support to women farmers. FAO asserts that small-scale poultry production will likely continue to provide income generation opportunities and quality human nutrition as long as there is rural poverty [6].

The per capita consumption of livestock products in Ghana is 4.42 kg/head/year which is very low not only compared to FAO recommended levels of 183 kg/head/year but also among countries within the West African sub-region resulting in severe protein deficiency among the populace [7, 8]. Livestock production in Ghana (cattle, sheep, goat, and hogs) declines and has remained low, compelling the nation to rely on import for more than 90% of its livestock and livestock products consumption requirements [4]. Thus, there should be a focus on other neglected, aspects of animal production, particularly micro-animals like pigeons, rabbits, grass cutters, quails, and cavy.

Pigeons play crucial role in the lives of people and are distributed throughout Ghana in low input Systems [6]. Pigeons (*Columba livia domestica*) live side by side with humans and are bred as source of food, hobby and for experimental aims and they have adapted to life in urban, suburban and rural environment and have close communication with humans [9–11]. As durable birds, pigeons (*Columba livia*) can be reared with little effort. A particularly promising urban micro livestock species is farmed pigeons because they need no or little space and thrive well in cities. Domestic pigeons are also part of subsistence farming done by most poor families, just like other domestic poultry. Pigeons are kept as pet and reared for food in several countries in Africa like Nigeria, Botswana, Egypt, including Ghana [11, 12]. Rearing pigeons for consumption is not nearly as widespread as it could be; indeed, in modern times its potential has hardly been utilized. They have fine textured meat that has an attractive flavor, and is often used in place of game fowl. The meat being tender and easily digested, it commands good market prices. In many areas, the continuing demand is unfilled and when given much attention, it would serve as a raw material for foreign exchange [13, 4]. Besides, these birds grow very fast and reach maturity quickly. For instance, a squab, the young pigeon reaches the stage of consumption from 25–30 days [14, 10]. They readily adapt to being fenced or penned most of the time or all of the time. When compared with the traditional farm livestock, they have short life cycles and high offspring production.

An integrated approach to characterization consisting of data on phenotypes, molecular markers, performance records and production systems should be used together for livestock improvement purposes. Phenotypic characterization is useful in obtaining a better understanding of the composition and developmental patterns of the breed and such understanding can aid a breeding program and can also be used to divide animals into species since it can reveal great diversity across species. There is quite an urgent need to characterize the specific traits of local populations. A more comprehensive characterization of these breeds and populations will facilitate their improvement and development, and could lead to monitored cross-breeding strategies, avoiding uncontrolled genetic absorption which might bring about the loss of the local genetic resources. It is noted that the utilization of local genetic resources first requires characterization of the population existing in the country [15, 16]. Successful avian reproduction depends also on various factors including age of birds, nutrition, conditions under which eggs are incubated, all year round/seasonally. Females usually lay two eggs within an interval of 40–44 h per session and removing the eggs from the nest can induce more frequent laying [17, 18]. The performance characteristics of the available pigeon population in Ghana have not been fully investigated. This study seeks to assess the performance characteristics of local pigeon in Ghana under deep litter system [19].

MATERIALS AND METHODS

Location of Study

The study was conducted at Nyankpala, which is about 18 km west of Tamale but located in the Tolon district in the Northern Region. The district lies between latitude 8°N, 11°N and longitude 0°E 3°W [20]. The Northern region, which occupies an area of about 25,459 km^2 is the second largest region in Ghana in terms of land mass. A mostly lowland region with relatively dry climate, has a single rainy season that begins in May and ends in October. The annual rainfall recorded varies between 750 and 1,050 mm. The start of the dry season is usually in November and ends in March/April with maximum temperatures occurring towards the end of the dry season (March–April) and minimum temperatures in December and January. The harmattan winds have a considerable effect on temperatures in the region. They usually occur from December to early February, making the temperature vary between 14°C at night and 40°C during the day. It is also characterized by very low humidity, aggravating the effect of the daytime heat. The situation (the rather harsh climatic conditions) adversely affects economic activities in the region both positively and negatively. The vegetation is characterized by grassland, interspersed with guinea savannah woodland, with drought-resistant trees [21, 22].

Sample size and Management of Experimental Birds

For performance traits measurement, a total of 50 pigeons were reared over a period of 5 months. In all, 25 males and 25 females were used. The birds were housed for 5 months in a deep litter house using the intensive system. 50 wall mounted local weaving lofts were provided for breeding pairs for nesting. Birds were fed with 2776.43 kcal/kg metabolizable energy and 20.142% crude protein percent (CP%). Feed and water were administered *ad libitum*. Detail of the feed composition is provided by Amal *et al.* [9]. Eggs were collected daily and identified using pair number, dovecot number and date laid.

Data Collection

Data on the following performance traits were collected:

- *Egg characteristics:* egg weight, egg length, egg width and shape index {Egg shape index = (egg width/egg length) ×100}.
- *Fertility of eggs:* the fertility of the eggs was determined by candling.
- *Hatchability of eggs:* This was determined using the percentage of eggs set that hatched.
- Incubation period.
- Squab body weight (from week-1 to week-4).
- Mortality of adult pigeons and squab over the 5-months period.

Statistical Analyses

The frequencies of the various performance characteristics were calculated using descriptive statistics of SPSS 17.0 [23]. Pearson's Correlation of SPSS v 17 was used to estimate correlation coefficients between the various external egg measurements [23].

RESULTS AND DISCUSSION

Performance of Pigeons Studied over 5-Months Period

Egg Production

Pigeons laid a pair of eggs in every session of their incubation. Hatchability and fertility percentages were recorded as 35.2 and 70.4 respectively (Table 1). For the duration of the study, egg laying never ceased. 18 hens out of the 25 laid a total of 54 eggs, two (2) eggs per session. Typically, there were two eggs to a clutch which is in agreement with present findings. It was obvious that pigeon are non-seasonal breeders, they produce all year round [24].

Egg Fertility and Hatchability

Hatching period or duration in this study was 16–17 days. The hatching period recorded in this study rhyme closely with earlier report by Saxena *et al.* which stated that, it takes a duration of 17–18 days for incubation of pigeon egg to take place [25]. Brooding of the egg is to promote the proper development

Table 1. Performance characteristics.

Performance characteristics	Flock mean
Number of eggs laid at a session	2
Fertility (%)	70.4
Hatchability (%)	35.2
Adult mortality (%)	8
Squab mortality (%)	21.1

of the young embryo, leading to a successful hatching and birth of the chick. Quite a number of factors, such as frequency of egg turning, duration, nest type, type of nursing of the brood, parent health status fresh air supply, weather conditions influence the incubation of eggs [26].

Egg fertility in this study was 70.4% with a hatchability percentage of 35.2. Darwati *et al*. reported 77% hatchability of pigeon, higher than the value in this study [27]. However, Ashraful Kabir reported hatching capacity of 98.92±1.04% for crossed indigenous pigeon in semi-intensive rearing [28]. It was reported by Khargharia *et al*. that the hatchability percentage in Assam breed was higher (84.98%) in monsoon season than (80.01%) in pre monsoon season with average hatchability of 82.86% which is much higher than the present study [29]. They further asserted that animal performance varies with years due to differences in climatic variables in different years. Danuta and Tomasz reported that egg fertilization rate in Polish Owl pigeons was 64.86%, which was 25% lesser than that of Warsaw Butterfly Tumbler pigeons [30]. Fertility rate of present findings is higher than the polish owl and lower than the tumbler. Hatchability was 97.2% in Polish Owl pigeons and 69.57% in Warsaw Butterfly Tumblers which are all higher than present study. The hatchability of homing pigeons, as reported by Zielinski and Pawlina, was 90.74%, but in King and Wrocław meat pigeons the mean observed was 75.76–76.00 [31]. According to Amal *et al*., the mean hatchability rate in the mud dovecotes system was 80.76% whereas 90.67% was under the wooden lofts system [9]. El-Hanoun *et al.* declared that hatchability percentage in the mud dovecotes for the Nile Delta region ranged from78 to 85.29% [32]. The low hatchability percentage recorded in this study might be due to genetic factors, environmental factors such as seasonal effect as the study was done in heat season and there is no selection for good hatching characteristics from the maternal ability. Literature data on average of hatchability for pigeons (in relation to fertilized eggs) vary substantially [33]. Thus, hatchability indices depend on many factors, including nutrition, age of birds, conditions under which eggs are incubated, etc.

Mortality

Adult mortality was 8% while squab mortality was 21.1% in the third phase of the data collection. This was due to casualties in young birds falling from dovecote. From the interaction with farmers in her study, 94.5% of respondents stated that pigeon mortality was low (0–5%) [24]. She further asserted that 28.9% cause of mortality was disease, 57.8% was predators and 8.9% was caused by pest. According to Amal *et al.*, high percentage of mortality was observed under the commercial mud dovecotes system (12.66%) followed by that of the family system (10.7%) [9]. They further stated that, the high mortality in the dovecotes systems was due to predators' attack. Ghosh *et al*. [34] reported 14.58% and Asaduzzaman *et al.* [35] recorded 5–15% mortality in pigeons. They also, stated that most of the mortalities occur from the attack of predators and diseases. The low mortality rate in the present study might be due to the hardy nature of the local Ghanaian pigeon, the controlled production environment/system and their ability to resist diseases.

Body Weight of Squab

The mean body weight at hatch of pigeons was 22.655 and 271.66 g at the end of week-4. Table 2 shows the weekly mean body weight. The growth performance and development of pigeon squabs are of crucial importance for meat producing as well as racing pigeons. The mean weekly body weight of the birds recorded in this study were lower than averages of body weight reported at week-1, 2, 3, 4 and

Table 2. Pigeon squab weekly mean body weight (±SE).

Age	Mean weight (g) (N=19)	± SE
Hatch	22.655	±1.119
Week-1	157.321	±6.230
Week-2	224.107	±8.227
Week-3	267.381	±3.827
Week-4	271.667	±3.321

30 of age of racing pigeons recorded as 79.10, 173.90, 233.55, 283.85 and 379.25 g, respectively in Egypt by Mohammed [10]. However, Gao *et al*., in their findings reported 18.7±0.9, 115.8±6.7, 280.7±7.8, 393.3±11.4 and 487.5±5.5 g for day-1, week-1, week-2, week-3 and week-4 respectively which were also higher than the present findings except that they recorded lower figure for day-1 [36]. Momoh *et al*. recorded 13.17±1.226, 108.62±7.00, 221.61±9.20 and 275.52±6.50 g for day-1, week-1, week-2, week-3 and week-4 respectively [37]. This difference may be due to differences in breed, nutrition, management, environmental and several other factors since these factors affect animals' weight and growth.

In this study, squab had faster initial growth rate for both male and female, probably due to regurgitation of a holocrine substance (crop milk) by both parents, though the rate slows down with age from week-3 to week-4. Weekly gains from day-1–week-4 were 134.666, 66.786, 43.274 and 4.286 g similar to the mean body weight gain of Jalali pigeon in India at 3-day, 15-day and 1-month of age reported as 31.68±1.08, 225.53±3.89 and 275.59±1.48 g respectively [28]. Extraordinarily high rate of maturing (0.1466 to 0.1945 g/d) has been exhibited by squabs when compared to other domesticated avian species such as quail (0.077 to 0.097 g/d) and chicken (0.0450 g/d). The achievement of this fast growth rate could be attributed to the regurgitation of a holocrine substance (crop milk) by both parents, triggered by brooding and formed in response to prolactin secretion in the body [38, 39].

At 28 days of age, pigeons reach mature body weight and the increase in weight after that is very low [40]. According to Danuta and Tomasz [30], between day-7 and day-14 of rearing, the body weight daily gains of pigeons were 8.83 to 12.61 g, and next decreased to reach 0.47 to 1.77 g between days-21 and 28, corroborating the observations in this present study. Ashraful, in his study stated that, Squabs grow quickly during the third week and slow in 4th week [28]. The age at 4 weeks is therefore the optimum when meat pigeons should be slaughtered, as keeping them further would be economically inefficient.

Squab Growth Rate

Young domestic pigeon had faster growth rate for both male and female but the rate slows down with age from day-1 to week-4. In all, over all weight gains of male squab was higher than female squab. Overall weight gains for male pigeons were 255.16 and female were 242.86. Figure 1 shows the weekly body weight gains of young male and female pigeons. This suggests existence of sexual dimorphism among pigeons [3].

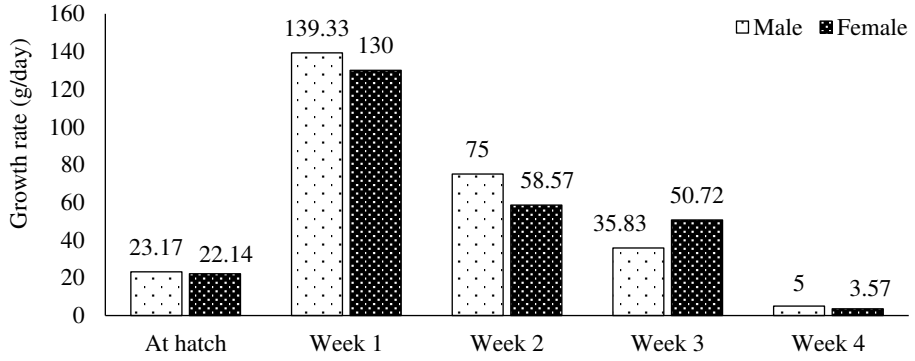

Figure 1. Growth rate of squabs against their ages (g/week) based on sex.

Egg Characteristics

The external egg measurements are presented in Table 3. The mean egg weight, length and width in this study were recorded as 26.350 g, 3.681 cm and 2.867 cm respectively with shape index of 78.095 (Table 3). In contrast, previous reports, Ibrahim and Sani found the mean egg weight of street pigeons (*Columba livia*) to be 14.46±0.11 g which is lower than the mean egg weight in the present study [41]. Several reports observed lower values for pigeon egg weight. For example, Darwati *et al*. reported egg weights ranging from 10.7 to 23.2 g with an average of 17.7±1.6 g [27]. Robinson reported the mean egg weight of 18.9 g for domestic pigeons [42]; but Sales and Janssens recorded mean egg weight of 21.4 g for domestic pigeon which is also lower but closer to values recorded in this present study [39].

These differences could be attributed to genetic and/or non-genetic influences on the various traits. Much heavier eggs, 22 g, has been reported for meat pigeons [33, 43]. Abou Khashaba *et al.* indicated that the egg weight of pigeons increased significantly with the diet metabolic energy content present in their diet [44]. *Columba livia* egg length and width were reported as 3.68 and 2.85 cm respectively in the study of Bhowmik *et al*. in Bangladesh, which corroborates the value in this study [45]. The hatching (incubation) period of Jalali pigeon obtained in the study of Bhowmik *et al.* was 18.00±0.09, which was 2 days more than the present study [45].

The egg color and shape in this study were white and oval, which possibly could increase hatchability. Jalali pigeons' egg color and shape were reported to be white and oval which are invariably the same with the reports of others [25, 29, 40, 45]. Pravez *et al.* studied 15 breeds of pigeons and discovered egg color and shape to be white and oval which is in agreement with present study [19]. Hatchability indices are impacted by the shape of eggs, since the proper position of the embryo is determined by the egg shape [20]. It has been demonstrated in poultry studies that hatchability may become heavily deteriorated if the shape index deviated from the species-characteristic average [46, 47]. Darwati *et al*. observed that egg shape index varies extensively in pigeons and ranged from 70.1–81.3% and which did not differ from the range recorded in this study [27]. The range of egg shape index in this present study was 74.4–96.6% with a mean of 78.090% (Table 3). This compared favorably with results obtained by research done by Olawumi and Ogunlade who reported an egg shape index of 76.18% in exotic ISA brown chicken eggs in Nigeria [48]. Scientist reported a shape index of 79.12% for Japanese quails in Turkey. Previous research reports on pigeon breeds indicated that egg shape index in Polish Owl pigeons was 73.04%, a 3% less than that of Butterfly Tumblers, Warsaw, which closely rhyme with our study findings.

Correlation between Egg External Measurements

Table 4 shows the correlation matrix of external egg characteristics in pigeons. The highest correlation was recorded between egg weight and egg length (0.847) and the lowest value recorded was between

Table 3. Means and standard errors of egg measurements.

Measurement	No.	Mean	±SE	Range	
Egg weight (g)	54	26.35	0.26	23	30
Egg length (cm)	54	3.68	0.02	3.4	4.0
Egg width (cm)	54	2.87	0.01	2.6	3.1
Egg shape index (%)	54	78.09	0.43	74.4	96.6

SE= standard error, and No.= number.

Table 4. Correlation external egg measurements (±SE).

	EW	EL	EWTH	ESI
EW	1.00			
EL	0.847**	1.00		
EWTH	0.684**	0.702**	1.00	
ESI	–0.121	–0.154	0.080	1.00

***significant (p<0.01), * significant (P <0.05), EW= egg weight, EL= egg length, EWTH= egg width, and ESI= egg shape index.*

shape index and egg length (–0.154). A strong positive correlation value (0.702) was observed between egg width and egg length. There was significant correlation between egg weight and egg length, and that of egg weight and egg width, confirming earlier report by Bhowmik *et al.* [45]. This means that egg length and width are important indicators of egg weight. This pattern of correlations was similar to that reported by Mogre for indigenous guinea fowls in northern Ghana [49]. His study found the positive correlations between egg length and egg width, egg weight and egg length, with negative correlations between shape index and egg weight, shape index and egg length [50–53].

CONCLUSION AND RECOMMENDATION

The study concludes that the local pigeons are highly prolific with faster growth rate, have high fertility, short hatching period (16–17 days) and commonly lay very few (only two) eggs per clutch. Low hatchability is a major problem affecting the local pigeons' productivity especially in heat seasons. There was significant correlation between egg weight and egg length, and egg weight and egg width.

Selection to improve the production performance of the pigeons should be incorporated in the objectives of breeding programs. The specific areas that require immediate improvement are body weight, egg laying, fertility and hatchability.

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