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LOCAL LIBYAN PIGEON: PHYSICAL CHARACTERISTICS OF THE EGG AND THE INFLUENCE OF HABITAT ON EGG QUALITY

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Abstract:

The pigeon (Columba livia) is widely distributed in Libya in different habitats, as domestic, feral or wild pigeons. The aim of this study is to describe the physical characteristics of eggs from the local Libyan pigeon breed in Al-Bayda city and its suburbs, and to examine the effect of habitat (feral vs. caged domestic) on egg quality. A total of ninety-six eggs (60 eggs from feral and 36 from domestic pigeons) were collected from a number of feral pigeon colonies and a private caged domestic pigeon farm. The average weight of the local pigeon eggs (both domestic and feral) was 15.72 g, with a length of 37.80 mm and a width of 28.18 mm. Egg components were dominated by albumin (67.85%) followed by yolk (23.72%) and egg shell (8.23%). Habitat significantly influenced most egg characteristics. Egg weight, width, shape index, Haugh unit, albumen height and percentage were higher in feral pigeon eggs compared to domestic pigeon ($p < 0.05$). Egg volume tends to be higher in feral pigeon eggs compared to domestic pigeon ($p=0.079$). Egg length was similar between the two groups. Yolk and shell percentage were higher ($p < 0.05$) and shell thickness tended to be higher ($p =0.08$) in domestic pigeon eggs compared to feral pigeon eggs. These results are in contrary to our hypothesis that habitat (e.g., stable feed supply and care) could positively affect egg characteristics of pigeons. Additional research at a larger scale is needed to further explore these findings.

Keywords: Pigeon, Feral, Domestic, Egg quality

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الحمام الليبي المحلي: الخصائص الطبيعية للبيضة وتأثرها بالموطن

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ملخص:

ينتشر الحمام (Columba livia) في مواطن مختلفة على نطاق واسع في ليبيا، كحمام مستأنس Domestic، أو مُستبر Feral ، أو بري Wild . تهدف هذه الدراسة إلى وصف الخصائص الطبيعية لبيض سلالة الحمام الليبي المحلي في مدينة البيضاء وضواحيها، ودراسة تأثير الموطن (مُستبر أو مستأنس مربى داخل اقفاص) على جودة البيض. جُمعت ست وتسعون بيضة (60 بيضة من الحمام المُستبر و36 بيضة من المستأنس) من عدد من مستعمرات الحمام المُستبر ومزرعة خاصة للحمام المستأنس المربى في اقفاص. كان متوسط وزن بيض الحمام المحلي (سواءً أكان مستأنساً أو مُستبراً) 15.72 جم، وبلغ طولها 37.80 مم وعرضها 28.18 مم. ساد الألبومين (67.85٪) مكونات البيضة، يليه الصفار (23.72٪) والقشرة (8.23٪). أثّر الموطن بشكل كبير على معظم خصائص البيض. كان وزن البيضة وعرضها ومعامل الشكل ووحدة Haugh وارتفاع الألبومين ونسبته، أعلى في بيض الحمام المُستبر مقارنةً بالحمام المستأنس ($P < 0.05$). يميل حجم البيض إلى أن يكون أعلى في بيض الحمام المُستبر مقارنةً بالحمام المستأنس ($P = 0.079$). كان طول البيض متشابهًا بين المجموعتين. كانت نسبة الصفار والقشرة أعلى($P < 0.05$). يميل سمك القشرة إلى أن يكون أعلى ($P = 0.08$) في بيض الحمام المستأنس مقارنةً بالحمام المُستبر. تتعارض هذه النتائج مع فرضيتنا القائلة بأن الموطن (مثل توافر اللغذاء والرعاية) يمكن أن يؤثر إيجابًا على خصائص بيض الحمام. نوصي بإجراء بحوث إضافية على نطاق أوسع لاستكشاف هذه النتائج بشكل أعمق.

الكلمات المفتاحية: حمام، مُستبر، مستأنس، جودة البيض.

Introduction

North Africa is the native home to the wild rock pigeon Columba livia (Shapiro and Damyan 2013). Pigeon population in Libya distributed in three habitats:1- domestic pigeons, 2- wild pigeon: which still existed in northern parts of the country (Jacobsen and Mikkelsen 2007) and inhabit mountainous rocky cliffs and caves, 3-feral pigeon: domestic pigeons that escaped domestic birds and inhabited the urban areas.

Although, Feral pigeons can effectively adapt to different urban environments (Rose et al. 2006), habitat can affect egg characteristics and breeding success (Nettleship 1972, Shatkovska et al., 2018). In great tits birds, egg volume was not affected by habitat, but

egg thickness was thicker in urban parks than in the woodland (Hargitai et al. 2016). Nager and Zandt (1994) proposed that great tits laid significantly smaller eggs only when both food abundance and temperature were low. Also, Janiga (1996) noticed that the increase of feral pigeon egg mass reflects access to high quality food. There was a discrepancy in the research results related to the effect of diet quality on egg characteristics: Meleg et al. (1999) reported that different dietary energy and protein levels did not affect average egg weight or egg components, contradicting the results of Bu et al. (2015), who reported that increasing the protein percentage of the diet resulted in an increase in shell percentage and egg length. Information on the external characteristics of eggs such as weight, shape, volume, egg thickness, surface area is vital to improving pigeon farming technology as well as in biological and ecological research. One of the major constraints in pigeon breeding is that, as an altricial bird, their squabs hatch underdeveloped and require parental care until weaning. The assessment of egg characteristics of local pigeons is needed to protect genetic biodiversity (Moula et al., 2010), since the breed faced a threat of crossing with exotic imported breeds.

This study aims to describe egg characteristics of local Libyan pigeons in Al-Bayda city and its suburbs and the effect of habitat (feral vs caged domestics) on egg quality. We hypothesize that habitat (e.g., stable feed supply and care) could positively affect egg characteristics of pigeons.

Material and methods

The research has been approved by Al-Mukhtar committee for Bio-safety and Bioethics (MCBB) under reference number: NBC: 007. A. 25. 31.

Eggs were collected from domesticated and feral pigeons. Candling was used to ensure that the egg was recently laid and did not develop an embryo.

1- Feral pigeons: sixty eggs were collected from a number of pigeon colonies located in public buildings. Colonies were located in Al-Bayda city 32°45′59″N 21°44′30″E and Al-Bayda suburb: Wardama and Al-Khuwaimat. Eggs were collected during different seasons of 2022, depending on availability.

2- Domesticated pigeons: thirty-six eggs were collected from a private closed breeding system farm. The farm is located in Ghirnada (32°43′48″N 21°54′22″E) southeast of Al-Bayda. The pigeons were raised in cages within a 4x4 m room, which housed 30 pairs of local pigeons.

In addition to wheat, small amounts of a feed mixture containing dari grains, lentils, beans, roasted soybeans, safflower, and buckwheat were provided occasionally to the pigeons. Greenline breeder tablets are provided, which is a mixture of vitamins, minerals and amino acids. The farm owner uses local pigeons as an incubator, where he removes the eggs as soon as they are laid and replaces them with eggs of foreign high-value breeds. He believes that local pigeons have stronger maternal instincts than those breeds. The eggs were collected during different seasons of 2022, depending on availability.

- Measurements

• Weights: The eggs, yolk and shell were weighed using a sensitive digital scale, PRECISA Series 320 XB - Model XB320M, and the egg white was estimated by difference. Eggs in which the yolk and white are mixed were weighed and excluded from the analysis.

• Dimensions: Length and width of the egg and diameter of the yolk were measured using a vernier scale. Yolk and white heights were measured by tripod micrometre.

• Eggshell was placed in a drying oven at 105°C and then weighed. Their thickness was measured by micrometre and registered as an average of three points: the wide end, middle and pointed end.

- Calculations

• Egg volume: was calculated according to the equation proposed by Hoyt (1979):

Volume of egg (cm^3) = 0.51*length of egg*square of egg width

• Egg shape factor: was calculated according to Narushin and Romanov (2002):

Egg shape factor (%) = width/length of egg*100

• Egg surface area: was calculated according to Narushin (2005):

Egg surface area (cm2) = (3.155 -0.0136*length of egg+0.0115*width of egg) *length of egg*width.

Haugh unit = 100 log [H + 7.57 - 1.7*W0.37], where H: white height and W: egg weight.

- Statistical analysis

Descriptive statistics were used to summarize egg characteristics of local pigeons. An unpaired t-test was used to compare the means of the two groups and the analysis was performed by Excel 2016.

Results and discussion

- Egg characteristics of local pigeon

According to Johnston and Janiga (1995), domestic breeds are the primary source of feral populations lived in the same area. So, we consider the total eggs from both domestic and feral pigeons in order to describe local Libyan pigeon egg characteristics in Al-Bayda and its suburbs. The characteristics of local pigeon eggs (feral and domesticated) were presented in Table 1.

Local pigeon eggs weighed 15.72 g, measured 37.80 mm in length and 28.18 mm in width. These estimates are comparable to the results previously reported (15.24 g, 3.60 cm, 2.70 cm) on local pigeon eggs (Akraim and Jadallah 2021, Akraim et al. 2022).

Egg weight and dimensions varied between breeds. Egg of the local Libyan pigeon in the studied region was lighter, shorter and thinner than White King or Carrier Pigeon's egg (Stęczny et al. 2024).

In this study, egg components were dominated by albumin (67.85%) followed by yolk (23.72%) and egg shell (8.23%). This is in agreement with egg components percentages reported on American White King (Chang et al. 2018) and on Carrier pigeon (Stęczny et al. 2024).

Table 1. Egg characteristics of the local pigeon across habitats.

Character	N.	mean	Range
Egg weight (g)	**96**	**15.72 ± 0.3**	**6.5-21.6**
Egg length (mm)	**96**	**37.80 ± 0.28**	**27.80-42.20**
Egg width (mm)	**96**	**28.18 ± 0.22**	**21.30-38.80**
Albumin height (mm)	**61**	**4.44 ± 0.16**	**1.37-9.95**
Yolk height (mm)	**73**	**11.40 ± 0.53**	**4.22-25.70**
Yolk diameter (mm)	**66**	**27.16 ± 0.31**	**22.30-35.90**
Yolk (%)	**52**	**23.72 ± 0.94**	**7.79-42.11**
Albumin (%)	**52**	**67.85 ± 1.31**	**27.66-85.75**
Shell weight (g)	**77**	**1.26 ± 0.03**	**0.84-2.21**
Shell thickness (mm)	**52**	**0.26 ± 0.03**	**0.12-1.02**
Shell (%)	**52**	**8.23 ± 0.26**	**4.72-14.14**
HU %	**53**	**85.73 ± 0.93**	**62.37-110.58**
Egg volume (cm^3)	**96**	**15.39 ± 0.28**	**6.43 -28.48**
Egg surface area (cm^2)	**96**	**31.57 ± 0.36**	**17.89-44.58**

Egg components vary between bird species. For example, in the northern gannet (Morus bassanus), yolk content is about 15.5% of egg mass (Ricklefs and Montevecchi 1979), and can represent up to 69% in the Kiwi (Apteryx) (Sotherland and Rahn 1987). As an altricial bird, pigeons have lower yolk content compared with other domestic poultry species like duck, goose or quail egg (Sun et al. 2019).

- Effect of habitat

As shown in Table 2, egg weight, egg width, egg shape index, Haugh unit, albumen height and percentage were higher in the feral pigeon eggs compared to domestic pigeon eggs ($p < 0.05$). Egg volume tended to be higher in feral pigeon eggs compared to domestic pigeons ($p=0.079$). Egg length was similar between the two groups. Yolk and shell percentage were higher in the domestic pigeon eggs compared to feral pigeons ($p < 0.05$).

As mentioned by Ricklefs (1984), and in agreement with our result, yolk size is poorly correlated with egg size. Habitat affects avian egg size (Ciach 2011, Hargitai et al., 2016, Shatkovska et al., 2018). Janiga (1996), Nager and Zandt (1994) proposed that habitat could influence egg characteristics mainly through food quality and abundance. We believe that in our study the domestic pigeons receive stable and good quality food supply in comparison with feral pigeons. In contrast, we found that eggs of domestic pigeon were significantly smaller, thinner, have less albumen height and shape index than feral pigeon eggs.

However, the owner of the domestic pigeon farm systematically removes the eggs of domestic pigeons and replaces them with eggs from valuable exotic pigeon breeds. Egg removal decreases egg yolk proportion (Jacquin et al., 2010). The findings of Jacquin and his colleagues (2010) are not in line with our results because we found that eggs of domestic pigeons have higher yolk proportion than feral pigeon eggs. It is worth mentioning that egg removal did not affect egg size (Jacquin et al., 2010, Gharib et al., 2024) and thus egg removal cannot explain the differences between domestic and feral egg characteristics in this study.

Time of eggs collecting in this study was dependent on the availability of eggs during the year of the study and we did not consider the effect of season. Variation in egg composition between feral and cage domestic pigeons may be related to the weather. According to Janiga (1996), winter eggs contained proportionally more albumen and less yolk than summer eggs. Local Libyan pigeon produced lighter egg and tend to produce

less egg number in summer in comparison with winter (Akraim and Jadallah, 2021). Studies also demonstrate geographical variation of egg weight of feral pigeons. Johnston and Janiga (1995) mentioned that feral pigeon eggs weight in Russia are on average less than 17 g, Western Europe average 17 g, southern India 13.5 g, Kansas state USA 14.60 g. Variation in egg weight could be related to differences between domestic breeds that makeup the feral pigeon population in these countries (Giunchi et al., 2020).

Egg yolk proportion of feral pigeons in Paris suburbs ranged from 18.5 to 21.5% (Jacquin et al., 2010) which is close to our results reported on feral pigeons. In contrast, the yolk proportion of domestic pigeon's eggs reported in our study was higher than the yolk percentage of other domestic pigeon breeds (Gugolek et al., 2013, Chen et al., 2016, sun et al., 2019). Egg component proportions vary between domestic pigeon breeds. Yolk percentage was higher in Carrier pigeons' egg than in king pigeons (Stęczny et al., 2024). Lewko and Gornowicz (2011) noticed that the yolk proportion in eggs from caged laying hens was higher compared with free-range birds.

Table 2. Effect of habitat on the local pigeon egg characteristics

	Domestic pigeon	Feral pigeons
Egg wt (g)	**$14.89^{b} \pm 0.50$**	**$16.16^{a} \pm 0.23$**
Egg length (mm)	**38.04 ± 0.43**	**37.65 ± 0.37**
Egg width (mm)	**$27.46^{b} \pm 0.29$**	**$28.57^{a} \pm 0.28$**
Albumen height (mm)	**$3.99^{b} \pm 0.17$**	**$4.81^{a} \pm 0.24$**
Yolk height (mm)	**12.29 ± 0.71**	**10.85 ± 0.73**
Shell thickness (mm)	**$0.30^{a} \pm 0.04$**	**$0.21^{b} \pm 0.01$**
HU	**$83.56^{b} \pm 1.22$**	**$87.57^{a} \pm 1.30$**
Egg volume (cm^3)	**14.76 ± 0.40**	**15.78 ± 0.37**
Shape index (%)	**$72.30^{b} \pm 0.61$**	**$75.11^{a} \pm 0.85$**
	Egg components (%)	
Albumen	**$65.60^{b} \pm 1.40$**	**$72.47^{a} \pm 1.35$**
Yolk	**$26.09^{a} \pm 1.07$**	**$20.81^{b} \pm 1.34$**
Shell	**$9.08^{a} \pm 0.41$**	**$7.38^{b} \pm 0.21$**
Yolk: albumen ratio	**$0.40^{a} \pm 0.04$**	**$0.29^{b} \pm 0.03$**

^{a,b} Means with different superscripts in the same row differ significantly ($p < 0.05$).

Eggshell thickness was not correlated with egg weight (Sabah and Şahan 2018), and varied between pigeon breeds (Stęczny et al. 2024). In our study, egg shell thickness of feral

pigeons (0.21 mm) was lower than egg shell thickness reported on feral pigeons in Korea (0.30 mm) (Nam and Lee 2006). We found that egg shell thickness of domestic pigeon was 0.30 mm, which is higher than egg shell thickness of domestic white king pigeon, Polish Shield Highfliers and Budapest Short Face Tumblers: 0.18, 0.20 and 0.17mm respectively (Gugolek et al. 2013, sun et al. 2019).

Conclusion

Our data provide the first detailed description of physical egg characteristics of local Libyan pigeons in Al-Bayda region of both feral and domestic birds. We found that eggs of local pigeons tend to be relatively small in size and have classical proportions of egg components of altricial birds. In spite of stable supply of good quality food of caged domestic pigeons, habitat significantly affected most of egg physical characteristics in favour of feral pigeons. Additional research at a larger scale is needed to further explore the effect habitat in this study.

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