Acta Sci. Pol. Zootechnica 20(1) 2021, 47–54

www.asp.zut.edu.pl pISSN 1644-0714 eISSN 2300-6145 DOI:10.21005/asp.2021.20.1.05

Short Communication

Received: 20.12.2020
Accepted: 15.03.2021

A PRELIMINARY STUDY ON SELECTED UTILITY TRAITS AND MINERAL COMPOSITION OF MEAT IN KING PIGEONS MANAGED UNDER EXTENSIVE SYSTEM IN POLAND

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ABSTRACT

The study was conducted on King pigeons managed by a private breeder in Poland. The studied population consisted of three years old parent pigeon pairs of the King breed and the their offspring obtained during the breeding season (March-November). The aims of the research involved an evaluation of the reproductive performance of King pigeons, analysis of growth rate, survival, slaughter performance and mineral composition of squab meat. In the analyzed breeding season, an average of 8.7 eggs was obtained per female. The fertilization rate and hatching rate of chicks from fertilized eggs were 80.0% and 75.8%, respectively. The highest weight gain in pigeons was observed between the date of hatching and 4 weeks of age. Pigeons slaughtered at 6 weeks of age were characterized by higher slaughter performance (66.1%) than 4 week-old pigeons (60.4%). Meat of this pigeon breed is a rich source of valuable minerals such as potassium (4060 mg per kg), magnesium (296 mg per kg), iron (52 mg per kg), zinc (9 mg per kg) and silicon (30 mg per kg).

Key words: body weight, dressing percentage, growth rate, hatchability

INTRODUCTION

Breeding of meat pigeons in some European countries (Denmark, Hungary, France, Germany, Italy) is a well developed branch of food production industry. Hungary is the largest exporter of pigeon meat [Borys and Pawlina 2010]. Meat pigeon breeds also play a significant role in the USA, Canada, China and Australia [Brzóska 2019, Kabir 2020]. Farming of meat pigeons in Bangladesh and Egypt provides the breeders with both food supply and income [Asaduzzaman et al. 2009, Omar et al. 2016]. In Poland, however, meat of pigeons is a marginal part of the poultry production. Small home farms are focused on obtaining pigeon meat for their own needs. In recent years, there has been an increase in the interest in this species of birds, from both amateur breeders and people interested in running professional farms. Modern consumer, in the face of excessive supply of meat from industrial farms, is looking for a product on the market obtained from birds fed without an addition of genetically modified components and free to use runs. Animal welfare and the natural way of husbandry are becoming a priority. It seems that pigeons can meet these requirements, since they are fed with a mixture of cereal grains and oilseeds and are kept in small groups in aviaries. In recent years, scientific research has been conducted on the development of fertility, growth rate and slaughter value of pigeons, but only a few reports relate to King pigeons [Gao et al. 2016, Bu et al. 2018, Wang et al. 2019, Kokoszyński et al. 2020]. Understanding the pigeon meat content of minerals that are important to the consumer can be helpful in assessing the nutritional importance of this raw material. Given the above, the aims of the research were:

- assessment of reproductive performance of King pigeons,
- analysis of the growth rate and survival of young pigeons,
- assessment of slaughter performance and mineral composition of squab meat depending on the age of slaughter.

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MATERIAL AND METHODS

The study was carried out on a private small farm in Poland. The experimental population consisted of 5 King parent pairs and their offspring (n = 31) obtained during the breeding season. The parental couples were three years of age. For identification purposes, adult pigeons were leg banded. The pigeons were kept in a wooden dovecote with an added aviary. The breeding wooden boxes (unit dimentions: 60 cm wide, 40 cm deep, and 40 cm high for each unit) placed on the wall of the building. During the breeding season pigeons were fed a mixture of maize (20%), naked barley (15%), wheat (10%), sorghum (20%), peas (15%) red lentils (10%) and rapeseed (10%). Calculated chemical composition of diet (14.4% total protein, 3183.2 MJ MEN and 3.8 raw fibre per 1 kg feed). In addition to concentrated feed, pigeons were given green crops, fruit, vegetables, boiled potatoes and crushed chicken eggshell. Birds also had permanent and unlimited access to water with vitamins (Polfamix A+Z), grit and clay. The mixture of cereals and seeds was served at will in automatic feeders. Throughout the study, all birds were watered and fed at will with the same feed.

During the breeding period, the number of eggs laid by individual females in each laying was recorded, which allowed determining the duration of the breeding season. The percentage of fertilized eggs, dead embryos, raised and dead chicks was calculated. After hatching, each chick was assigned an individual number written on the leg-band. At weekly intervals, the weight of the young pigeons was monitored to determine the growth rate, which was calculated according to the formula:

$$t_w = \frac{m_k - m_p}{\frac{1}{2}(m_p + m_k)}$$

where:

t_w – growth rate in a given period,
m_p – body weight at the beginning of the period,
m_k – body weight at the end of the period.

The pigeons were slaughtered at age 4 (n = 12) and 6 (n = 12) weeks. Before slaughter squabs were fasted for 12 h. Total body weight, gutted carcass, stomach, heart and liver were recorded. The lean yield and the percentage of offal per carcass were calculated. Body weight and carcass weight was determined using an electronic balance with a precision to 1g. The weight of day-old chicks and the weight of offal were determined using an electronic jewelry scale with a precision to 0.1 g. All procedures on animals have been carried out in accordance with applicable EU and Polish regulations.

The levels of macro- and microelements in muscles were determined by inductively coupled plasma optical emission spectrometry using the Optima 2000 DV (ICP-AES. PerkinElmer Inc., Uberlingen, Germany) following digestion in a microwave oven type Multiwave (Anton Paar GmbH, Gratz, Austria) equipped with a system of continuous temperature and pressure control in each quartz vessel. The weighted amount of tissue homogenate, weighing about 1 g, was transferred to a pressure quartz glass vessel, into which 5.0 ml of 65% HNO_3 (Suprapur, Merck) and 0.5 ml of 30% H_2O_2 (Suprapur, Merck) were successively added. Mineralisation was conducted according to the equipment application mode MEAT: 0–5 min at linear gradient of power 100–600 W, 6–10 min at 600 W (const.), 11–20 min at 1000 W or less after reaching 75 MPa or 300°C, 21–35 min cooling. The cooled and degassed mineralisate was filled up to 10 ml in volumetric flasks.

Microelements (Cu, Fe, Se, Si, Zn) were directly determined in the solutions prepared this way, whereas mineralisates were diluted 10- or 100-fold for the determination of macroelements (Ca, Mg, Na, K and P) in order to obtain the range of linear dependence of emission signal on the concentration of a given mineral component. Measurements of the intensity of emitted radiation for micro-elements were made selecting a longer, axial optical path (along plasma), whereas macro-elements were analysed radially (across plasma). As standard, a certified multi-element solution for ICP (ICP Multielement Standard IV, Merck) was used. Standard solutions were supplemented with the addition of acid used in mineralisation, in the concentration which occurred in mineralised samples. In order to minimise potential interferences in sample introduction to plasma and other physical disturbances, analyses were made using the internal standard method by yttrium (Y) introduction into sample and standard solutions in a concentration of 0.5 mg Y/L.

The STATISTICA 10.0 PL package was used for mathematical and statistical processing of the resulting data. Means and standard deviations (SD) of the examined traits were calculated. The significance of differences was estimated by the Student *t*-test.

RESULTS AND DISCUSSION

The results of pigeon reproductive performance in the analyzed breeding season are presented in Table 1. The breeding season began in the early spring, initiated by the increasing duration of the natural light day. Most couples began the reproductive season in the second half of March and ended in the first half of November. Many birds adjust their clutch size to environmental conditions, producing smaller clutches, when food is scarce, and larger ones, when it is abundant.

The number of laying days ranged from 58 to 246 days and averaged 152 days. In the studies of Mikulski and Pudyszak [2002], the laying lasted 189 days for the King breed and 158 and 185 days for the Wrocław meat

Table 1. Reproductive performance of King pigeon during the breeding season

Item	Pair					
	1	2	3	4	5	x̄
Lenght of laying period*, days	238	246	106	111	58	151.8
Total clutch number	5	6	3	4	2	4
Number of eggs laid per female per season, pcs	10	12	6	8	4	8
Number of egg in clutch, pcs	2	2	2	2	2	2
Infertile eggs, pcs	2	2	0	0	0	0.8
Infertile eggs, %	20.00	16.67	0	0	0	7.33
Fertile eggs, [pcs]	8	10	6	8	4	7.2
Fertile eggs, %	80.00	83.33	100.00	100.00	100.00	92.66
Dead embryos, pcs	0	0	0	2	0	0.4
Dead embryos %	0	0	0	25.00	0	5
Healthy chicks, n	8	10	6	6	4	6.8
Healthy chicks, %	80.00	83.33	100.00	75.00	100.00	87.66
Died chicks, n	1	0	2	0	0	0.6
Died chicks, %	10.00	0	33.33	0	0	8.6
Reared chicks, n	7	10	4	6	4	6.2
Reared chicks, %	87.50	100.00	66.67	100.00	100.00	90.8

* reproduction period represents the time span between the moments of laying the first and the last egg

pigeon and Europigeon, respectively. The breeding season of the Polish Lynx pigeon in the study of Mikulski and Pudyszak [2002] lasted 195 days. According to Nowicki and Pawlina [2002], the interval between subsequent layings is 35 to 40 days. In our study, the interval between hatchings ranged from 32 to 65 days, on average about 43 days. Our observations show that the period between the layings significantly increased during hot summer months.

Females always laid two eggs in one laying. The number of layings by one female ranged from 2 to 6, which gives respectively 4 to 12 eggs from the female during the breeding season (Table 1) Zieleziński and Pawlina [2007] obtained an average of 13 eggs from one female, while Mikulski and Pudyszak [2002] recorded significantly lower productivity – on average 6–7 eggs per female. Wang et al. [2019] report that the longer daily photoperiod significantly improved egg production in King pigeons. In our study, we did not apply any additional light stimulation.

Egg fertilization in the analyzed breeding season was about 80% (Table 2). In the study of Zieleziński and Pawlina [2007], the percentage of fertilization in King pigeons was similar and amounted to 81.4%. The percentage of fertilized eggs in homing pigeons in the studies of the above authors was 94.1%, while in Wrocław meat and Strasser breeds this value was 82.4 and 83.9%, respectively. This is confirmed by the fact that reduced fertility and laying performance are the negative effects of selection for weight gain in pigeons of meat breeds. In the study of Zieleziński and Pawlina [2007], the hatchability of King and Wrocław meat breeds was 75–76%, which was similar to 75.8% our results. The best hatching rates in the cited studies were in homing pigeons 91%. Mikulski and Pudyszak [2002] obtained an impressive result of 100% hatching rate in King and 68.8% in Wrocław pigeons. The hatching performance of the Lynx breed in the studies of Mikulski and Pudyszak [2002] was 78.8%. The reproductive success of birds depends on many factors, including nutrition, age of the breeders, incubation conditions, and season. Therefore, the hatchability indexes of fertilized pigeon eggs reported in the cited literature vary greatly. Wang et al. [2017] report that by introducing 1.0 mg of sodium selenite per kg into the diet of pigeons, egg production, hatchability, and sperm quality can be significantly improved.

In our research, 84% of chicks were raised up to 28 days of age. The survival rate of the offspring up to the age of 30 days according to the studies of Mikulski and Pudyszak [2002] was 62.5% in King and 72.7% in Wrocław pigeons. Polish Lynx in the research of Mikulski and Pudyszak [2002] raised 73% of their offspring to 30 days of age. In the study of Zieleziński and Pawlina [2007], the lowest death rates were noted in rearing of King pigeons (10%), while in Strasser and

Wrocław meat the mortality rates to 28 days of age were respectively 14.4 and 15.3%.

The increase in body weight and growth rate of pigeon chicks is influenced by many factors: genotype, age, health condition, number of chicks in the nest, number of feeding parents, body weight at hatching, quantity and quality of taken feed and water, hygienic conditions in the breeding cell and loft, the age of the parents, the quality of parental care and the farmer's care [Darwati et al. 2010, Gao et al. 2016, Miąsko and Łukasiewicz 2016, Abdel Fattah et al. 2019]

Fig. 1 shows the growth curve of young meat pigeons until 42 days of age. The average body weight of one-day-old chicks was 21.4 g (Fig. 1). In our study, pigeons at the age of 7 days were lighter by about 13 g than those described by Zieleziński and Pawlina [2011a] for the King pigeon, while on 28 days they were 29 g heavier. In the study of Zieleziński et al. [2004], King pigeons on days 7 and 14 were heavier than those in our studies and weighed 259.0 g and 490.8 g, respectively, and were lighter on day 21 and 28, 554.4 g and 588.2 g, respectively. Similar results to ours achieved hybrids of Strasser × King in the studies of the above cited authors. Zieleziński and Pawlina [2011b] recorded the highest body weight in all age groups in King pigeons, closely followed by Wrocław meat pigeons, and Strasser pigeons, which were smallest.

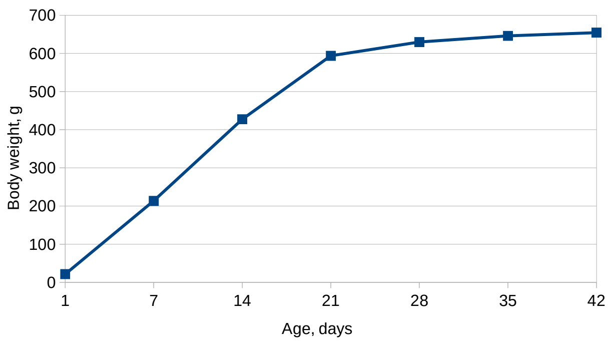

Fig. 1. Growth curve of King pigeons (n = 32)

In our studies, young pigeons grew most intensively up to 21 days of age (Table 2). As reported by Zieleziński and Pawlina [2007], the chicks double their body weight already at 48 hours of age. In the first week of life, Zieleziński and Pawlina [2011b] found large daily weight gains, 32 g. Weight gains in our study were 27.4 g, till day 7, and 31 g, from 7 to 14 days of age. After 21 days of age, there was a drop in daily gains, hence the finishing should end at age 28 days. Gao et al. [2016] also claim that 28 day of life is the latest market age for meat type pigeon.

The pigeons exhibited the most intensive growth rate between days 1 and 7 of age, when it started to slow down (Table 2). Abdel-Azeem et al. [2016], who studied a local Egyptian pigeon population, noticed that growth of squabs was quick during the first 28 days, reached the peak and decreased or stopped afterwards. Darwati et al. [2010] reports for a local Indonesian pigeon that the squab weight increased from week 0 to 4 and decreased in week 5. The growth rate was highest during week 1, then decreased from week 2 to 5 with the negative growth rate occuring during week 5.

In our study, pigeons slaughtered at 6 weeks were heavier by 46 g than those slaughtered at 4 weeks of age, the differences were not statistically significant, though (Table 3). Body weight of King pigeons on the 28th day in the studies of Szmańko et al. [2001] was 750 g and was higher by about 142 g than obtained by pigeons of the same age in our research.

In our study, pigeons slaughtered in the 6th week of life were characterized by greater slaughter performance than 4 weeks old pigeons. However, the average slaughter performance of 4-week-old birds was about 10% lower than that given by Zieleziński and Pawlina [2011]. In the studies of the cited authors, slaughter performance was the highest in meat pigeons of the Wrocław meat breed, 74.6% and the lowest in homing pigeons, 70.3%. Szmańko et al. [2001] and Miąsko and Łukasiewicz [2016] obtained the highest slaughter performance in hybrids of Wrocław meat × Giant Homer and Giant Homer × King pigeon, slaughtered on the 28th day of life. In the research of Gao et al. [2016] conducted in China on King pigeons, 85.46 and 87.0% slaughter yield was obtained in 28 and 35 days old pigeons, respectively. The differences between our research data and those of other authors result from the fact that the slaughter value of poultry is significantly influenced by a number of factors, generally classified as genetic or environmental. The main factors are: species, utility type, age and general housing conditions [Le Bihan-Duval 2004, Uhlířová et al. 2018, Ahmad et al. 2019, Węglarz et al. 2020]. Jiang et al. [2019] demonstrated that dietary supplementation with DL-Methionine and DL-Methionyl-DL-Methionine in breeding pigeons effectively improved the carcass characteristics and meat quality of squabs.

In our study, 4 week old pigeons were characterized by a higher relative mass of the liver than pigeons slaughtered at a later age (Table 3). However, the relative weight of the heart and stomach was proportionally higher in older pigeons. The mass of heart and liver of both age groups in our study was lower than in the study of Szmańko et al. [2001]. Only the liver weight of slaughtered pigeons at 4 weeks of age was greater than the results presented by the above authors. It should be added that Szmańko et al. [2001] studied the weight of offal and their share (%) in pigeon carcass with and without feathers, and in our study the share of heart, liver and stomach in body weight was noted.

Table 2. Weight gain and growth rate over King pigeon rearing period

Age, days	Weight gain				Growth rate	
	g		%		%	
	x̄	SD	x̄	SD	x̄	SD
1–7	192.01	37.31	89.82	1.58	163.13	5.19
8–14	214.06	48.72	49.87	5.78	66.82	10.28
15–21	166.25	54.76	27.76	7.72	32.69	10.41
22–28	35.94	61.69	5.50	9.77	6.20	11.17
29–35	3.50	53.14	0.58	8.13	0.90	8.27
36–42	8.50	29.24	1.16	4.33	1.25	4.43

Table 3. Slaughter performance and participation of selected organs in the body weight of young King pigeons

Item	Age, weeks			
	4		6	
	x̄	SD	x̄	SD
Body weight, g	608.33	65.34	654.50	79.24
Carcass weight, g	366.67[A]	45.59	432.50[A]	52.70
Slaughter performance, %	60.36[A]	5.21	66.13[A]	3.57
Liver, g	16.92[a]	3.92	14.24[a]	2.78
Liver, %	2.79[A]	0.64	2.17[A]	0.27
Gizzard, g	10.09[A]	1.24	11.72[A]	1.77
Gizzard, %	1.67	0.21	1.80	0.26
Heart, g	4.91[a]	1.01	5.92[a]	0.71
Heart, %	0.80[a]	0.13	0.91[a]	0.08

A – statistically significant differences at $P \leq 0.01$.
a – statistically significant differences at $P \leq 0.05$.

The content of minerals in the pigeon's pectoral muscles is shown in Table 4. There was no significant effect of pigeon age on the content of potassium and phosphorus in meat. In the pectoral muscles of 6-week-old pigeons, a higher content of sodium and magnesium was noted, while a lower calcium content. The content of macroelements in the tested material can be ordered as follows: Ca < Mg < Na < P < K. Studies of pigeon meat undertaken by many authors concerned the content of fat, the proportion of fatty acids, cholesterol and protein [Zieleziński et al. 2004, Pomianowski et al. 2009a, Gao et al. 2016, Kokoszyński et al. 2020].

Due scarce or lacking literature on pigeon meat mineral profile, a comparison of the reported data with prior research proved elusive. Our research shows that pigeon pectoral muscles are more abundant in macroelements (P, Mg, Ca) than the pectoral muscles of broilers studied by Al-Yasiry et al. [2017]. Poławska et al. [2013] compared in terms of mineral content different types of meat, namely ostrich, beef, pork, horse meat, nandu meat, chickens and rabbits, indicating the highest potassium content in rabbit meat, 4280–4310 mg per kg. A similar content of this element was found in pigeon meat (Table 4). Sodium in pigeon meat is in the amount of 615–780 mg per kg (Table 4) as in meat of broiler chickens (770 mg per kg) evaluated by Poławska et al. [2013]. The lowest sodium content (360 mg per kg) is characteristic for ostrich [Majewska et al. 2009]. Calcium, according to Poławska et al. [2013], was highest in chicken meat, 180 mg per kg, but according to Karakök et al. [2010], in quail meat. Ostrich and pigeon meat contains a similar amount of calcium, 55 mg per kg.

The meat of young meat-type pigeons in our research contained more magnesium, calcium, sodium, phosphorus and potassium than turkey meat assessed by Pomianowski et al. [2009]. Zinc occurs in a similar amount in turkeys and pigeons. Pigeon meat matches the content of sodium and magnesium in mutton and lamb [Williams 2007].

Micronutrients play an important role in human nutrition, as they are responsible for maintaining the homeostasis of the body [Górniak et al. 2018]. In our re-

Table 4. The content of macro and microelements in the pectoral muscles of young King pigeons, mg per kg

Item	Age at slaughter			
	4 weeks		6 weeks	
	x̄	SD	x̄	SD
K	3994.30	439.77	4125.67	466.78
P	3124.91	234.11	3099.57	350.31
Na	780.45[A]	54.99	616.02[A]	79.70
Mg	286.3[a]	13.85	305.81[a]	27.69
Ca	55.23[a]	7.34	45.23[a]	11.52
Fe	53.46	11.67	51.68	7.78
Si	37.37[A]	11.43	23.24[A]	8.08
Zn	8.54	1.00	8.82	1.00
Cu	3.45[A]	0.62	4.38[A]	0.67
Se	0.10	0.05	0.11	0.06

A – statistically significant differences at $P \leq 0.01$.
a – statistically significant differences at $P \leq 0.05$.

search, the content Fe, Si, Zn and Cu of these elements was, respectively 52.57, 30.30, 8.68 and 3.91 mg per kg (Table 4). Poultry meat is a good source of iron and zinc. On average, 20–40% of the daily demand for zinc is covered by meat and meat products. In our research, zinc content ranged from 8.5 to 8.8 mg per kg, similarly to turkey muscles assessed by Pomianowski et al. [2009]. Beef, lamb and mutton represent a much richer source of this element [Williams 2007]. The selenium content in our study was 0.1 mg per kg, similar to deer and horse meat [Poławska et al. 2013]. The research of Majewska et al. [2009] shows that the ostrich contains twice as much content of selenium. According to the literature, the content of minerals in poultry muscles depends on many factors, like the mineral composition of the diet, the source of minerals, the intensity of nutrition, sex, origin of the bird and the type of muscles [Vecerek et al. 2005, Świątkiewicz et al. 2014, Baloch et al. 2017]. The available literature lacks information on the influence of these factors on the mineral profile of pigeon meat, therefore research in this direction should be conducted. The knowledge on the mineral content in animal food products is very important, especially in terms of the composition of the human diet, which is at the end of the food chain.

CONCLUSION

Based on the results, it can be stated that King pigeons are characterized by good hatching performance and satisfactory offspring rearing parameters. Meat of this pigeon breed is a rich source of valuable minerals such as potassium, magnesium, iron, zinc and silicon. These studies may also constitute comparative material for further research.

ACKNOWLEDGEMENT

The research was financed from subsidies for conducting research and maintaining research potential at West Pomeranian University of Technology in Szczecin.

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WSTĘPNE BADANIA WYBRANYCH CECH UŻYTKOWYCH I SKŁADU MINERALNEGO MIĘSA GOŁĘBI RASY KING UTRZYMYWANYCH SYSTEMEM EKSTENSYWNYM W POLSCE

STRESZCZENIE

Badania przeprowadzono na gołębiach mięsnych rasy king utrzymywanych przez prywatnego hodowcę w Polsce. Populację eksperymentalną stanowiły trzyletnie pary rodzicielskie gołębi rasy king oraz potomstwo uzyskane od tych par w czasie sezonu rozpłodowego (marzec-listopad. Celem badań była ocena użytkowości reprodukcyjnej gołębi, oraz analiza tempa wzrostu, przeżywalności, wydajności rzeźnej i składu mineralnego mięsa młodych gołębi w zależności od wieku uboju. W analizowanym sezonie rozrodczym pozyskano średnio 8,7 jaj od jednej samicy. Zapłodnienie i wylęgowość piskląt z jaj zapłodnionych wynosiły odpowiednio 80,0 i 75,8% Największe przyrosty masy ciała u gołębi stwierdzono w okresie od wyklucia do 4 tygodnia życia. Gołębie ubijane w 6. tygodniu charakteryzowały się większą wydajnością rzeźną (66,1%) niż gołębie 4. tygodniowe (60,4%). Mięso tej rasy gołębi stanowi bogate źródło wartościowych z punktu widzenia żywieniowego pierwiastków takich jak: potas (4060 mg na kg), magnez (296 mg na kg), żelazo (52 mg na kg), cynk (9 mg na kg) i krzem (30 mg na kg).

Słowa kluczowe: masa ciała, wydajność rzeźna, tempo wzrostu, wylęgowość

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