Journal of Microbiology, Biotechnology and Food Sciences
International peer-reviewed scientific online journal
Published by Faculty of Biotechnology and Food Sciences

# MEAT PERFORMANCE AND PHYSICOCHEMICAL EVALUATION OF PIGEON MEAT

*Peter Haščík*[1], *Adriana Pavelková*[1], *Martin Fik*[2], *Ondřej Bučko*[2]

***Address(es):***
[1]Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Institute of Food Sciences, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.
[2]Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources, Institute of Animal Husbandry, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.

*Corresponding author: peter.hascik@uniag.sk

https://doi.org/10.55251/jmbfs.10997

ARTICLE INFO

Received 5. 2. 2024
Revised 27. 3. 2024
Accepted 16. 4. 2024
Published xx.xx.201x

Regular article

OPEN ACCESS

**ABSTRACT**

The aim of the work was to evaluate the meat performance, colour and basic chemical composition (g.100 $g^{-1}$ of water, protein, fat, and cholesterol) of the breast and tight muscles (n=20) of the California pigeons. The L* values of the California pigeons ranged from 33.38 (breast muscle) to 43.63 (tight muscle) and significant differences (P≤0.05) were observed between the breast and tight muscle. The a* value ranged from 10.03 (tight muscle) to 14.77 (breast muscle). By evaluating the b* parameter, we observed a similar tendency as with the L* value. The highest values were measured in the tight muscle (11.50) and lower in the breast muscle (9.84). The proportion of breast (42.80%) and tight (14.90%) from the carcass weight of California pigeons is relatively high, and a high average carcass yield (71.12%) was also found. The water content varied from 70.51% (tight muscle) to 72.37% (breast muscle). The average protein content of breast and tight muscle was 23.68 g.100 $g^{-1}$. The higher fat content was measured in tight muscle (2.95 g.100 $g^{-1}$) and lower (1.21 g.100 $g^{-1}$) in breast muscle. The cholesterol content in meat from California pigeons ranged from 0.044 g.100 $g^{-1}$ (breast muscle) to 0.071 g.100 $g^{-1}$ (tight muscle).

**Keywords:** pigeon, meat performance, colour, chemical composition

## INTRODUCTION

With the improvement in people's living standards is the increasing demand for high-quality foods. The demand for functional food has greatly increased over the last decade with attention mainly to the quality of consumed meat. Nowadays, in addition to conventional types of meat, there is a growing interest in society for meat from alternative animal species, such as deer **(Volpelli *et al.*, 2003)**, ostriches **(Horbanczuk, 2002)**, quail **(Ayyub *et al.*, 2014)** and pigeons **(Zieleziński & Pawlina, 2005).** Pigeon meat is considered a delicacy and is gaining popularity among people **(Zieleziński & Pawlina, 2005; Pomianowski *et al.*, 2009; Ji *et al.*, 2020).**

Pigeon meat has been consumed by rural populations of the world since old times and is recognized as delicious and nutritious poultry meat. The pigeon meat represents not only a dietetic meat (recommended for post operatory diets or in general for the clinical cases that require a special diet) but also a significant economical production with a high protein level, low fat quantity and cholesterol and highly digestible **(Buculei *et al.*, 2010)**. Moreover, it is considered a good source of different types of vitamins, as well as essential minerals **(Paripuranam, 2014; USDA, 2020)**.

Native pigeon breeds are characterized by lower fattening, slaughter, and breeding yield parameters, but their advantages include good quality raw meat, lower feeding demands, natural resistance to bad environmental conditions, and higher resistance against illnesses and stress in comparison to regular industrial breeds **(Migdał *et al.*, 2020)**.

Around 50 breeds/genotypes of meat-type pigeons are currently known, but only a few of them have a large share in the production of pigeon meat around the world **(Brzoska, 2019)**.

The meat of pigeons, especially breast meat, is very nutritious because it is rich in high-value protein and low in cholesterol. However, leg meat, is characterized by a relatively high fat content, as well as high energy value **(Hossain *et al.*, 1994)**.

However, knowledge in terms of the chemical composition and nutritional value of pigeon meat, it is limited. Consumers often demand information about the nutritional composition of foods and the quality of the products consumed **(Cooper & Horbanczuk, 2002; Horbanczuk, 2002)**.

The objective of our study was to evaluate the meat performance, colour and basic chemical composition of the breast and thigh muscles of California pigeon meat.

## MATERIAL AND METHODS

In the verified experiment, 20 pcs California pigeons (10 females, 10 males) was used as the biological material. The pigeons were 3 months old and came from farm breeding. Table 1 and 2 indicate composition of feed mixtures for pigeon and supplied different grit/mineral. The pigeons were euthanized and slaughtered in a permitted manner and transported in cooling boxes to the Institute of Food Sciences, SUA Nitra.

### Slaughter and measurements

California pigeons were killed in accordance with the European Union Regulation 1099/2009 on the protection of animals at the time of killing, and then the carcass was dissected according to Hasčík *et al*. (2020).

### Chemical composition

We determined the basic chemical composition of breast and thigh muscles using Fourier transform infrared spectroscopy (FTIR), with a Nicolet 6700 device according to the methodology of Čech *et al.* (2021) and Haščík *et al.* (2023).

**Table 1** Composition of feed mixtures for pigeon

| **Ingredients** | **(kg.100 $kg^{-1}$)** |
|---|---|
| Wheat | 31.95 |
| Canola seed | 3.05 |
| Peas | 30.00 |
| Corn | 10.00 |
| Pigeon balancer | 10.00 |
| Safflower seed | 15.00 |
| **Nutrient content (g.$kg^{-1}$)** | |
| Linoleic acid | 18.85 |
| Fibre | 79.00 |
| Crude protein | 159.68 |
| Ca | 13.30 |
| P | 6.19 |
| Na | 6.18 |
| $ME_N$ (MJ.$kg^{-1}$) | 12.35 |

**Table 2** Mineral supplement (kg.100 kg$^{-1}$)

| Mineral | Composition |
|---|---|
| Shell grit | 34.00 |
| Granite | 40.00 |
| Limestone | 20.00 |
| Salt | 6.00 |

**Meat colour measurement**

Color measurements of breast and thigh muscle samples were performed using a spectrophotometer (Konica Minolta CM-2600d, Osaka, Japan) with the Specular Component Included (SCI) setting according to Bianchi, Fletcher & Smith (2005).

**Statistical analysis**

The data obtained were subjected to analysis of variance (ANOVA) using SAS software (version 9.3, Enterprise Guide 4.2, USA). Tables show the results as the mean with standard deviation (SD) **(SAS, 2008)**.

## RESULTS AND DISCUSSION

The results of the analysis of California pigeon carcasses are presented in **Table 3. Omojola *et al.* (2012)** reported that the pigeon live BW ranges between 250 to 350 g, BW ranges between 70 to 100%, CW ranges between 150 to 200 g, respectively. The percentage of CY, eviscerated yield, breast muscle yield and leg muscle yield of pigeon ranges between 82 to 88%, 62 to 69%, 20 to 27%, and 5 to 8%, respectively **(Jiang *et al*., 2019)**. **Kokoszyński *et al.* (2020)** indicated BW of King pigeon from 463.60 g (♀) to 471.30 g (♂) and from 274.80 g (♀) to 327 g (♂) in Carrier pigeon. **Majewska *et al.* (2021)** reported in 6-weeks old of King pigeon BW (654.50 g), CW (432.50 g), CY (66.13%), weight of liver (14.24 g), gizzard (11.72 g), and heart (5.92 g). Opposite to our experiment, other authors (Omojola *et al*., 2004; Abulude *et al*., 2006; Paripuranam, 2014; Omar, Hassan & Shahin, 2017) found higher live BW, CW, or CY in male than in female pigeons. From the point of view of the California pigeons meat performance, we found significant differences (P≤0.05) between the sexes only in the weight of the breast muscle.

**Table 3** Meat performance of California pigeon (g)

| Parameter | ♀ | ♂ | ♂ + ♀ | *p-value* (♂ : ♀) |
|---|---|---|---|---|
| Live BW | 535.23±12.39 | 510.55±42.79 | 520.42±36.14 | 0.345 |
| CW | 332.18±21.21 | 310.52±28.76 | 319.18±28.09 | 0.282 |
| Giblets | 50.80±2.64 | 50.05±5.39 | 50.35±4.51 | 0.823 |
| Heart | 5.80±0.64 | 5.12±0.74 | 5.39±0.778 | 0.214 |
| Liver | 10.40±0.58 | 9.47±2.073 | 9.84±1.71 | 0.455 |
| Gizzard | 12.65±0.76 | 12.30±1.85 | 12.44±1.52 | 0.756 |
| Neck | 21.95±2.53 | 23.33±3.58 | 22.78±3.27 | 0.566 |
| Abdominal fat | 1.45±0.59 | 1.97±1.14 | 1.76±0.99 | 0.475 |
| Gizzard fat | 1.85±0.59 | 1.97±0.93 | 1.92±0.81 | 0.847 |
| CY (%) | 71.52±3.14 | 70.86±4.27 | 71.12±3.87 | 0.818 |
| Breast part | 143.15±7.79 | 131.78±8.83 | 136.33±10.11 | 0.099 |
| Breast muscle | 113.10±5.51$^{a}$ | 101.97±4.97$^{b}$ | 106.42±7.53 | 0.018 |
| Tight part | 47.33±2.09 | 47.50±4.99 | 47.43±4.08 | 0.954 |
| Tight muscle | 25.28±0.59 | 26.83±3.29 | 26.21±2.69 | 0.427 |
| Wings | 65.03±4.88 | 61.60±7.74 | 62.97±6.95 | 0.502 |
| Breast part of CW (%) | 43.13±1.03 | 42.57±1.88 | 42.80±1.62 | 0.643 |
| Breast muscle of CW (%) | 34.11±1.43 | 33.01±2.15 | 33.45±1.97 | 0.447 |
| Tight part of CW (%) | 14.27±0.54 | 15.30±0.93 | 14.90±0.94 | 0.111 |
| Tight muscle of CW (%) | 7.64±0.58 | 8.64±0.70 | 8.24±0.82 | 0.067 |

Notes: BW – live body weight; CW – carcass weight; CY – carcass yield; mean±SD (standard deviation); a, b = means significant differences between column (P≤0.05) determined with Duncan test.

**Table 4** Chemical composition of the most valuable parts of California pigeon (g.100 g$^{-1}$)

| Parameter | ♀ | ♂ | *p-value* (♀:♂) | ♂ + ♀ | *p-value* breast muscle : thigh muscle (♂ + ♀) |
|---|---|---|---|---|---|
| **Breast muscle** | | | | | |
| Water | 72.09±0.58 | 72.56±0.44 | 0.225 | 72.37±0.55$^{a}$ | 0.007 |
| Total Protein | 24.38±0.42 | 24.23±0.72 | 0.747 | 24.29±0.62$^{a}$ | <0.0001 |
| Crude Fat | 1.23±0.11 | 1.19±0.25 | 0.775 | 1.21±0.21$^{b}$ | 0.001 |
| Cholesterol | 0.046±0.01 | 0.043±0.01 | 0.189 | 0.044±0.01$^{b}$ | <0.0001 |
| **Thigh muscle** | | | | | |
| Water | 69.95±1.47 | 70.88±1.08 | 0.324 | 70.51±1.30$^{b}$ | |
| Total Protein | 23.38±0.91 | 22.85±1.06 | 0.482 | 23.06±1.03$^{b}$ | |
| Crude Fat | 2.93±0.93 | 2.96±0.50 | 0.961 | 2.95±0.70$^{a}$ | |
| Cholesterol | 0.072±0.002 | 0.069±0.01 | 0.734 | 0.071±0.01$^{a}$ | |

Notes: mean±SD (standard deviation); a, b = means significant differences between column (P≤0.05) determined with Duncan test.

No significant differences were detected (P≥0.05) between the male and female California pigeons in the chemical composition of breast and tight muscles **(Table 4)**. In a joint group of California pigeon's female and male, we found significant differences (P≤0.05) in chemical composition between breast and tight muscles. Other authors found the following chemical composition of breast and tight muscles in pigeons. Compared to our results, Pomianowski *et al.* (2009) lower water content (66.52 to 70.59 g.100 g$^{-1}$), protein (21.73 to 23.61 g.100 g$^{-1}$) and significantly higher fat content (4.32 to 7.07 g.100 g$^{-1}$) in different breeds of pigeons found comparable water content (68.78 to 70.15 g.100 g$^{-1}$), lower protein content (20.56 to 21.72 g.100 g$^{-1}$) and significantly increased fat content (7.13 to 7.85 g.100 g$^{-1}$) in breast muscle and tight muscle. **Kokoszyński** *et al.* (2020) found the water content in the breast muscle 66.40 to 66.50 g.100 g$^{-1}$ and in the tight muscle 61.50 to 62.10 g.100 g$^{-1}$ in the King pigeon breed; the protein content was similarly higher (26.30 to 27.50 g.100 g$^{-1}$) compared to our experiment in breast muscle versus tight muscle (20.50 to 21.20 g.100 g$^{-1}$). **Kokoszyński** *et al.* (2020) found like Pomianowski *et al.* (2009) compared to our results clearly higher fat content in breast (4.20 to 5 g.100 g$^{-1}$) as well as in tight muscle (11.90 to 13.30 g.100 g$^{-1}$).

In comparison with other poultry species, Pavelková *et al.* (2020); Rebezov *et al.* (2020); Čech *et al.* (2021); **Włodarczyk** *et al.* (2021) found the water content in breast muscle from 70.70 g.100 g$^{-1}$ (broiler chickens) to 77.40 g.100 g$^{-1}$ in turkeys; protein content 18.90 g.100 g$^{-1}$ (turkey) to 24.55 g.100 g$^{-1}$ (quail); the fat content was from 0.97 g.100 g$^{-1}$ (chicken) to 3.50 g.100 g$^{-1}$ (partridge). In the tight muscle, the water content was from 69.38 g.100 g$^{-1}$ (quail) to 77 g.100 g$^{-1}$ (turkey); protein content from 18.60 g.100 g$^{-1}$ (turkey) to 23.32 g.100 g$^{-1}$ (quail); fat content from 1.30 g.100 g$^{-1}$ (quail) to 5.25 g.100 g$^{-1}$ (partridge).

The content of cholesterol in both muscles of the California pigeon was lower in the breast (44 mg.100 g$^{-1}$) than in the tight muscle (71 mg.100 g$^{-1}$), but higher than found by Pomianowski *et al.* (2009) in King and Wroclawski pigeons (23.6 to 44.4 mg.100 g$^{-1}$ tissue). It should be emphasized that the cholesterol content in the meat of California pigeons is slightly lower than the value given for chicken breast muscle (47.1 mg.100 g$^{-1}$ tissue; Ponte *et al*., 2004), turkey meat (34.2 to 84.8 mg.100 g$^{-1}$ tissue; Paleari *et al*., 1998; Komprda *et al*., 2002), ostrich meat (63 to 68.4 mg.100 g$^{-1}$ tissue; Horbanczuk *et al*., 1998) and nandu meat (75.2 mg.100 g$^{-1}$ tissue; Horbanczuk *et al*., 2004).

**Table 5** Evaluation of California pigeon meat colour

| Muscle | L* | a* | b* |
|---|---|---|---|
| Breast ♂ | 33.36±2.69 | 14.51±1.29 | 9.65±1.96 |
| Breast ♀ | 33.42±1.15 | 15.15±1.12 | 10.13±1.26 |
| *p-value* | 0.972 | 0.492 | 0.708 |
| Tight ♂ | 42.76±4.51 | 10.06±1.64 | 11.28±1.28 |
| Tight ♀ | 44.95±6.07 | 9.99±1.56 | 11.83±0.83 |
| *p-value* | 0.575 | 0.957 | 0.521 |
| Breast ♂ + ♀ | 33.38±2.21$^{b}$ | 14.77±1.26$^{a}$ | 9.84±1.73$^{b}$ |
| Tight ♂ + ♀ | 43.63±5.30$^{a}$ | 10.03±1.61$^{b}$ | 11.50±1.16$^{a}$ |
| *p-value* (♂ + ♀) | <0.0001 | <0.0001 | 0.028 |

Notes: mean±SD (standard deviation); a, b = means significant differences between column (P≤0.05) determined with Duncan test.

The evaluation of California pigeon meat colour is stated Table 5. The quality of muscle is usually reflected in the meat colour, pH, and drip loss. Among them, meat colour is the most visual indicator of physiological and biochemical changes in muscle. Muscle brightness values are influenced by the myoglobin and fat deposition content of the muscle, with red values reflecting the myoglobin content and yellow values reflecting the influence of ration pigments **(Mir *et al*., 2017)**. Many previous studies on the assessment of pectoral muscle meat colour have shown that the smaller the L* value, the larger the a* value, and the smaller the b* value, the better the muscle quality and vice versa **(Wu *et al*., 2018; Wen *et al*., 2020)**.

Flesh colour does not contribute much to muscle flavour, but it has been regarded as a flesh-quality trait mainly because it is affected by the meat's protein structure, myoglobin chemical state, and lipid oxidation **(Cao *et al.*, 2021).**

The colour has a key role during meat purchasing. It is considered to reflect the freshness and suitability of meat for certain culinary purposes. **Jiang *et al.* (2019)** observed a darker colour (lower L*, higher a*) in the breast muscles of 28-day-old White King pigeons. **Dong *et al.* (2019)** noted higher L* values (from 40.37 to 41.66) and higher b* values (from 14 to 17.40) in 25-day-old pigeons compared to the birds in our study. In turn, **Bu *et al.* (2018)** found higher redness (a*) and yellowness (b*) values in White King pigeons.

## CONCLUSION

The male California pigeon had a similar slaughter weight and carcass weight to the female. The high proportion of breast in pigeons across the trunk makes the pigeon unique as a meat producer and ensures relatively sufficient slaughter yield. The pigeon meat is characterized by a high nutritional value. Due to its low cholesterol content and relatively high protein content, it can be used as a valuable inclusion in the human diet. Due to the achieved meat yield and idle nutritional value, the pigeon industry provides an opportunity for its further expansion on a global basis, which is probably the largest in rural areas.

**Acknowledgments:** This work was supported with KEGA 001SPU-4/2023.

## REFERENCES


Abulude, A. O., Adesiya, W., Akinjaginla, Y. & Akinbuti, P. (2006). Studies on pigeon birds (Columba livia) anatomical weight, proximate composition, selected mineral contents and sensory evaluation. *Journal of Agricultural and Food Chemistry*, 5(4), 1473-1478.

Ayyub, R. M., Mushtaq, M. H, Bilal, M. & Akram, M. R. (2014). A study of consumer behaviour regarding quail meat product development and marketing. *Science International (Lahore)*, 26(2), 871-874.

Bianchi, M., Fletcher, D. L., & Smith, D. P. (2005). Physical and functional properties of intact and ground pale broiler breast meat. *Poultry Science*, 84(5), 803-808. https://doi.org/10.1093/ps/84.5.803

Brzoska, F. (2019). Squabs-fattened slaughter pigeons are exclusive poultry, part I. *Pol. Poult*., 3, 77-78

Bu, Z., Chang, L. L., Tang, Q. P., Song, C., Zhang, R., Fu, S. Y. & Mu, C. Y. (2018). Comparative study of meat quality, conventional nutrient composition and muscle fibre characteristics of White pigeons between different age and gender. *Journal of Food Safety and Quality*, 9(1), 13-18.

Buculei, A., Gontariu, I. & Rebenciuc, I. (2010). Comparative study regarding the aging influence upon the quality of pigeon and turkey meat. *Scientific Papers*, 53, 485-490.

Cao, C. G, Xiao, Z. C., Tong, H. Q., Tao, X. S., Gu, D. H., Wu, Y. L., Xu, Z. Q. & Ge, C. R. (2021). Effect of ultrasound-assisted enzyme treatment on the quality of chicken breast meat. *Food and Bioproducts Processing*, 125, 193-203. https://doi.org/10.1016/j.fbp.2020.11.005

Čech, M., Haščík, P., Pavelková, A., Čuboň, J., Bučko, O., Tkáčová, J., Kačániová, M., Bobko, M., Imrich, I. & Šár, K. (2021). Chemical composition of muscle after red grape pomace application in the nutrition of broiler chickens. *Journal of microbiology, biotechnology and food sciences*, 10(6), e3726. https://doi.org/10.15414/jmbfs.3726

Cooper, R. G., & Horbanczuk, J. O. (2002). The anatomical and physiological characteristics of ostrich (*Struthio camelus var. domesticus*) meat determine its nutritional importance for man. *Animal Science Journal*, 73(3), 167-173. https://doi.org/10.1046/j.1344-3941.2002.00024.x

Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing http://data.europa.eu/eli/reg/2009/1099/oj

Dong, X., Can, H., Mao, H., Hong, Q. & Yin, Z. (2019). Association of MyoD1 gene polymorphisms with meat quality traits in domestic pigeons (Columba livia). *Journal of poultry Science*, 56(1), 20-26. https://doi.org/10.2141/jpsa.0170182

Haščík, P., Čech, M., Čuboň, J., Bobko, M., Arpášová, H., Pavelková, A., Kačániová, M., Tkáčová, J., & Čeryová, N. (2020). Effect of grape pomace supplementation on meat performance of broiler chicken Ross 308. *Journal of Microbiology, Biotechnology and Food Sciences*, 10(1), 140–144. https://doi.org/10.15414/jmbfs.2020.10.1.140-144

Haščík, P., Pavelková, A., Čech, M., Jurčaga, L., Mesárošová, A. & Fik, M. (2023). Physicochemical evaluation of badger (*Meles Meles*) meat. *Journal of Microbiology, Biotechnology and Food Sciences*, 13(3), e10423. https://doi.org/10.55251/jmbfs.10423

Horbanczuk, J. (2002). The Ostrich. Eur. Ostrich Group, Ribe, Denmark.

Horbanczuk, J., Cooper, R. G., Jóźwik, A., Klewiec, J., Krzyżewski, J., Chyliński, W., Kubasik, W., Wójcik, A. & Kawka, M. (2004). Total fat, cholesterol and fatty acids of meat of grey nandu (Rhea americana). *Animal Science Papers and Reports*, 22(2), 253-257.

Horbanczuk, J., Sales, J., Celeda, T., Konecka, A., Zięba, G. & Kawka, P. (1998). Cholesterol content and fatty acids composition of ostrich meat as influenced by subspecies. *Meat Science*, 50(3), 385–388. https://doi.org/10.1016/s0309-1740(98)00028-x

Hossain, M J., Salah Udolin, M., Jalil, M. A., Yasmin, T., Paul, D.C. & Chamda, G. C. (1994). Meat composition of indigenous pigeons as influenced by sex, age and seasons. *Asian-Australasian Journal of Animal Sciences*, 7(3), 321-324. https://doi.org/10.5713/ajas.1994.321

Ji, F., Zhang, D., Shao, Y., Yu, X., Liu, X., Shan, D., & Wang, Z. (2020). Changes in the diversity and composition of gut microbiota in pigeon squabs infected with Trichomonas gallinae. *Scientific Reports*, 10(1): Article number 19978. https://www.doi.org/10.1038/s41598-020-76821-9

Jiang, S. G., Pan, N. X., Chen, M. J., Wang, X. Q., Yan, H. C. & Gao, C. Q. (2019). Effects of Dietary Supplementation with dl-Methionine and dl-Methionyl-dl-Methionine in Breeding Pigeons on the Carcass Characteristics, Meat Quality and Antioxidant Activity of Squabs. *Antioxidants*, 8(10), 435. https://doi.org/10.3390/antiox8100435

Kokoszyński, D., Stęczny, K., Żochowska-Kujawska, J., Sobczak, M., Kotowicz, M., Saleh, M., Fik, M., Arpášová, H., Hrnčár, C. & Włodarczyk, K. (2020). Carcass Characteristics, Physicochemical Properties, and Texture and Microstructure of the Meat and Internal Organs of Carrier and King Pigeons. *Animals*, 10(8), 1315. https://doi.org/10.3390/ani10081315

Komprda, T., Sarmanova, I., Zelenka, J., Bakaj, P., Fialova, M. & Fajmonova, E. (2002). Effect of sex and age on cholesterol and fatty acid content in turkey meat. *Archiv fur Geflugelkunde*, 66(6), 263-273.

Majewska, D., Pohorecki, T. & Matysiak, B. (2021). A preliminary study on selected utility traits and mineral composition of meat in king pigeons managed under extensive system in Poland. *Acta Scientiarum Polonorum Zootechnica*, 20(1), 47-54. https://doi.org/10.21005/asp.2021.20.1.05

Migdał, W., Kulig, R., Walczycka, M., Węsierska, E., Zając, M., Tkaczewska, J., Kulawik, P., Migdał, Ł., Migdał, A. & Krępa-Stefanik, K. (2020). The quality of traditionally smoked tenderloins obtained from meat of native pig breeds. *Biotechnology in Animal Husbandry*, 36(1), 49-61. https://doi.org/10.2298/BAH2001049M

Mir, N. A., Rafiq, A., Kumar, F., Singh, V. & Shukla, V. (2017). Determinants of broiler chicken meat quality and factors affecting them: a review. *Journal of Food Science and Technology*, 54, 3997–3009. https://doi.org/10.1007/s13197-017-2789-z

morphology and meat quality of yellow broilers. *Chinese Journal of Animal Nutrition*, 30, 5118-5126.

Omar, M. A., Hassan, F. A., & Shahin, S. E. (2017). Economic Assessment of Various Levels of Protein and Energy in Pigeon Squabs Diet. Zagazig Veterinary Journal, 45(S1), 20-30. https://doi.org/10.21608/zvjz.2019.28653

Omojola, A. B., Adesehinwa, A. O. K., Madu, H. & Attah, S. (2004). Effect of sex and slaughter weight on broiler chicken carcass. *Journal of Food, Agriculture & Environment*, 2(3&4), 61-63.

Omojola, A. B., Isa, M. A., Jibir, M., Ajewole, B. T., Garba, S., Kassim, O. R., Omotoso, A. B., Adeyemo, O. A. & Akinleye S. B. (2012). Carcass characteristics and meat attributes of pigeon (Columbia livia) as influenced by strain and sex. *Journal of Animal Science Advances*, 2(5), 475-480.

Paleari, M. A., Camisasca, S., Beretta, G., Renon, G., Corsico, P., Bertolo, G. & Crivelli, G. (1998). Ostrich meat: Physico-chemical characteristics and comparision with turkey and bovine meat. *Meat Science*, 48(3-4), 205-210. https://doi.org/10.1016/s0309-1740(97)00091-0

Paripuranam, D. (2014). Proximate, physical and mineral compositions of pigeon meal used as fish bait. *Journal of Chemical and Pharmaceutical Research*, 6(1), 669-673.

Pavelková, A., Haščík, P., Kalafová, A., Capcarová, M., Čuboň, J., Bučko, O. Kačániová, M., Hanusová, E., Tkáčová, J. & Bobko, M. (2020). Chemical composition of muscle after bee bread application in the nutrition of Japanese quails. *Journal of Microbiology, Biotechnology and Food Science*, 9(4), 831-835. https://doi.org/10.15414/jmbfs.2020.9.4.831-835

Pomianowski, J. F, Mikulski, D., Pudyszak, K., Cooper, R. G., Angowski, M., Jóźwik, A. & Horbańczuk, J. O. (2009). Chemical composition, cholesterol content, and fatty acid profile of pigeon meat as influenced by meat-type breeds. Poultry Science, 88(6), 1306-1309. https://www.doi.org/10.3382/ps.2008-00217

Ponte, P. I. P., Mendes, I., Quaresma, M., Aguiar, M. N. M., Lemos, J. P. C., Ferreira, L. M. A., Soares, M. A. C., Alfaia, C. M., Prates, J. A. M. & Fontes, C. M. G. A. (2004). Cholesterol levels and sensory characteristics of meat from broilers consuming moderate to high levels of alfalfa. *Poultry Science*, 83(5), 810–814. https://doi.org/10.1093/ps/83.5.810

Rebezov, Y. M., Shcherbakov, P. N., Bezhinar, T. I., Safronov, S. L., Vinogradova, N. D. & Morozova, L. A. (2020). Comparative analysis of the chemical composition of turkey meat of different breed groups in the conditions of the South Urals. *IOP Conference Series: Earth and Environmental Science*, 613, 012-122. https://doi.org/10.1088/1755-1315/613/1/012122

SAS. (2008) 9.3 Enhanced Logging Facilities, Cary, NC: SAS Institute Inc., 2008.

USDA Nutrient Database. Squabs (Pigeon), Meat Only, Raw. Available online: https://fdc.nal.usda.gov/ index.html (accessed on 10 March 2020).

Volpelli, L. A., Valusso, R., Morgante, M., Pittia, P. & Piasentier, E. (2003). Meat quality in male fallow deer (Dama dama): Effects of age and supplementary feeding. *Meat Science*, 65, 555-562. https://doi.org/10.1016/s0309-1740(02)00248-6

Wen, Y. Y., Liu, H. H., Liu, K., Cao, H. Y., Mao, H. G., Dong, X. Y. & Yin, Z. Z. (2020). Analysis of the physical meat quality in partridge (Alectoris chukar) and its relationship with intramuscular fat. *Poultry Science*, 99(2), 1225–1231. https://doi.org/10.1016/j.psj.2019.09.009

Włodarczyk, K., Kokoszyński, D., M. Saleh, M., Kotowicz, M. & Wasilewski, P. D. (2021). Effects of sex on carcass composition and physicochemical, textural and rheological properties of meat from grey partridge. South African Journal of Animal Science, 51(5), 647-656. http://dx.doi.org/10.4314/sajas.v51i5.11

Wu, S., Jiang, B. Y., Song, Z. H., Hou, D. X., Shi, S. R. & He, X. (2018). Effects of botanical polyphenol on antioxidant capacity, intestinal

Zieleziński, M., & Pawlina, E. (2005). Użytkowanie mięsne gołębi (Pigeon breeding for meat). *Pol. Drob*., (9), 44–47. (in Polish).