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COMPARISON OF MEAT OXIDATIVE STABILITY FREE-REARING AND FARM-REARING PHEASANTS

Jana Tkáčová[1], Peter Šmehýl[2], Adriana Pavelková[1], Marek Bobko[1], Juraj Čuboň[1], Peter Haščík[1], Mária Angelovičová[3], Miroslav Kročko[1], Martina Gondeková[4]

Address(es): Ing. Jana Tkáčová, PhD.
[1]Slovak University of Agriculture, Faculty of Biotechnology and Food Sciences, Department **of Evaluation and Processing of Animal Products,** 949 76, Nitra, Tr. A. Hlinku 2, Slovakia.
[2]Slovak University of Agriculture, Faculty of Agrobiology and food resources, Department of poultry science and small animal husbandry, 949 76 Nitra, Nitra, Tr. A. Hlinku 2, Slovakia.
[3]Slovak University of Agriculture, Faculty of Biotechnology and Food Sciences, Department of Food Hygiene and Safety, 949 76, Nitra, Tr. A. Hlinku 2, Slovakia.
[4]Animal Production Research Centre, Nitra, Department of Animal Breeding and Product Quality, Hlohovecká 2, 951 41 Lužianky, Slovakia.

*Corresponding author: jana.tkacova@uniag.sk

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ABSTRACT

The aim of this work was to compare contents of fat and oxidative stability of farm-rearing and free-rearing common pheasant (*Phasianus colchicus)*. For experiment were used pheasants from two types of breeding. The first group came from free-rearing and it was fed by a natural way and in the winter months were fed with wheat, maize and barley. For the experiment analysis were used from free and farm-rearing 10 male of pheasants and 10 female of pheasants. The second group was created by pheasants, which came from farm breeding from VPP Kolíňany farm, Žirany resort. The group of farm-rearing pheasants was reared in farm conditions until the time of hunt (70 days). The pheasants were fed by special feed mixtures (BŽ1, BŽ2, BŽ3) intendent for fattening of pheasants. All pheasants were caught on common hunting in Nitra area. The first meat analyzes were carried out 1 day after the pheasants hunting. Other samples were analyzed after 6 months of freezing storage. The different contents of fat in breast muscle was significant (P≤0.05) between groups farm-rearing and free-rearing and contents of fat was significant (P≤0.05) between male and female into group too. The contents of malondialdehyde (MDA) in breast muscle was in range from 0.025 to 0.056 mg.kg^{-1} at the start of storage (1st day) and at the end of storage (6th month) was in range from 0.113 to 0.197 mg.kg^{-1}. The significant differences (P≤0.05) in contents of MDA were between male and female from farm-rearing in sixth month of storage. The significant differences (P≤0.05) in contents of MDA were between group farm-rearing and free-rearing at the beginning and at ending of storage.

Keywords: oxidative stability, malondialdehyde, pheasant, free-rearing, farm-rearing

INTRODUCTION

Meat from wild-living game is a highly valued food (**Paulsen *et al*., 2008; El-Ghareeb *et al*., 2009; Hofbauer *et al*., 2010**). Currently, the common pheasant is the most abundant, widespread and economically important non-migratory game bird in Europe (**CABS, 2010**; **Quaresma *et al*., 2016**). In the past, animals were mostly associated with hunting, but nowadays, a freely available commodity is increasing in popularity (**Standarová *et al*., 2012; Hrabčáková *et al*., 2013a**).
Currently, it is possible to see an increasing trend in consumption of feathered game in Slovakia. Although wild-living game currently represents only a tiny fraction of the total meat consumption. Its dietary value is very high and corresponds to the demands of modern man for nutrition (**Hell *et al*., 2008**). For the last years, poultry breeding became the most extensively developing branch of animal husbandry (**Genchev *et al*., 2008**). Common Pheasant (*Phasianus colchicus*) is bred on farms for hunting purposes in many countries (**Torres *et al*., 1995; Canning, 2005; Gonzáles-Redondo and García-Domínguez, 2012; Hrabčáková *et al*., 2013b**).
Consumers favor meat that is authentic, tasty, rich in protein and low in lipid **(Franco and Lorenzo, 2013)**.
Similarly to other white meats, pheasant meat has high protein and low fat contents, an interesting proportion of essential and unsaturated fatty acids, and high content of certain B-group vitamins (**Večerek *et al*., 2005; Quaresma *et al*., 2016**). Due to its specific composition (low fat content, high protein content, favorable ratio of essential and unsaturated fatty acids) is this commodity frequently sought by consumers (**Standarová *et al*., 2012; Hutařová and Večerek, 2013**).
Meat from wild-living game with its low fat contents belongs to a group of meats very rich in protein. These proteins have an extraordinary biological value and are known to be highly used in the construction of human body proteins (**Vodňanský *et al*., 2009**). Pheasant meat is characterized by high nutritive value, as evidenced by high protein contents of breast (23.5-25.2%) and leg muscles (19.4-22.7%), and low proportion of fat (0.6-1.1%), especially in breast muscles (**Večerek *et al*., 2005; Kuźniacka *et al*., 2007; Gašparovič *et al*., 2017**) and 2.0-5.1% in leg muscles (**Večerek *et al*., 2005**). In terms of fat, the meat of the pheasant contains the highest proportion of unsaturated fatty acids - 70.67 g.100 g^{-1} of total fatty acids (**Vodňanský *et al*., 2009**).
The contents of most amino acids in breast and thigh muscles (in relation to dry matter) is higher in pheasants than in broiler chickens (**Straková *et al*., 2006; Gasparovic *et al*., 2017**) in addition, vitamins contain higher amounts of pantothenic acid, vitamin B6, riboflavin and thiamine. Low fat contents also results in low cholesterol contents (**Vodňanský *et al*., 2009**). Due to its low fat contents, the energy content of the wild-living game is considerably low (**Čuboň *et al*., 2012**).
A number of authors, **Tucak *et al*. (2004)**, dealt with comparing the quality pheasant meats of farmed and wild breeding farm pheasant meats while poultry needs to be fed concentrated, easily digestible forms of feeds that supply not only adequate amounts, but also a good balance of nutrients (**Ravindran, 2014**).
Lipid oxidation, called "autoxidation," is the result of radical chain reactions that occur in three simultaneous phases (initiation, propagation and completion). The resulting products depend on the substrates, which are generally unsaturated fatty acids (**Guyon *et al*., 2016**). The beginning of oxidation is influenced by temperature, light or metal ions **(Angelovič et al., 2015)**. The two first phases lead to the formation of radicals, which are rapidly transformed into non-radical compounds such as conjugated dienesand hydroperoxides, which are both considered primary products of lipid oxidation. These compounds decompose further and give rise to carbonyl compounds, ketones, alcohols, and aldehydes, which are considered secondary products of lipid oxidation (**Guyon *et al*., 2016**).

Malondialdehyde (MDA) is a relatively stable secondary product of the oxidative degradation of polyunsaturated fatty acids (PUFAs). It is a three-carbon dialdehyde that can exist in various forms depending on the pH value. Cyclic peroxides, biclyclic endoperoxides, and hydroperoxyl are some of its major precursors (**Lima *et al*., 2013; Amaral *et al*., 2018**). MDA is important for industry and scientific research since it can be used to determine lipid peroxidation through the TBARS test (Thiobarbituric Acid Reactive Substances), the most widely used assay to assess the effects of lipid oxidation on meat and meat products **(Min and Ahn, 2005; Amaral *et al*., 2018**).

Another important secondary oxidation products are the volatile compounds responsible for the off-odor and off-flavor such as propanal, hexanal and pentanal (**Barriuso *et al*., 2013; Lorenzo *et al*., 2013; Guyon *et al*., 2016; Cunha *et al*., 2018**).

MATERIAL AND METHODS

For the experiment was used common pheasant *Phasianus colchicus* - commonly hunted feathered game bird in Slovakia. For the purpose of the experiment, pheasants were used from two types of breeding. The first group was imagined by pheasants that were from free-rearing. Individuals obtained food in a natural way and were fed in the winter months with wheat, maize and barley. For the experiment analysis were used 10 male pheasants and 10 female pheasants from free-rearing and from farm rearing.

The second group was created by pheasants, which came from farm breeding from VPP Kolíňany farm, Žirany resort. The pheasants were fed by special feed mixtures for fattening pheasants.

The feed mixture BŽ1 was used from 1 to 21 days, BŽ2 was used from 22 to 42 days and BŽ3 was used from 43 to 70 days of feeding period. Young pheasants aged from 8 to 10 weeks were removed to outdoor aviaries and hold there until the day of hunt. The compositions of basal diets are shown in Table 1. The group of farmed pheasants was reared in farm conditions until the time of hunt.

Table 1 Composition of feed mixtures

Ingredients (%)	Starter (BŽ1) (1st – 21st day of age)	Grower (BŽ2) (22nd – 42th day of age)	Finisher (BŽ1) (43nd – 70st day of age)
Wheat bran	5	-	-
Fish meal (71% N)	4	5	5
Dried blood	5	5	5
Dried yeast	2	2.5	5
Soybean meal (4% N)	14	31.3	18
Extracted groundnut	-	10	10
Maize	33	26.5	36.7
Wheat	7	10	10
Barley	25	-	-
Shelled oats	-	5	5
Dried vitamins	5	3	3
Fodder salt	-	0.2	0.3
Monocalcium phosphate	-	0.5	1
Dicalcium phosphate	-	1	1
Nutrient composition (g.kg^{-1})			
NL	min 260.0	min 240.0	min 130.0
ME (MJ.kg^{-1})	min 11.5	min 11.5	min 11.5
Ash	max 80.0	max 80.0	max 80.0
Fiber	max 60.0	max 60.0	max 60.0
Lysine	min 16.0	min 10.0	min 4.0
Methionine and cysteine	min 9.0	min 4.0	min 4.0
of this methionine	min 5.0	min 3.0	min 3.0
Ca	min 11.0	min 11.0	min 11.0
P	min 7.0	min 7.0	min 6.0
Na	1.5 -4.5	1.5-4.5	1.5-4.5
Mn (mg.kg^{-1})	min 95.0	min 95.0	min 95.0
Fe (mg.kg^{-1})	min 60.0	min 60.0	min 60.0
Cu (mg.kg^{-1})	min 6.0	min 6.0	min 6.0
Zn (mg.kg^{-1})	min 90.0	min 90.0	min 90.0
Vitamin A (mj.kg^{-1})	min 10000	min 10000	min 10000
Vitamin D_3 (mj.kg^{-1})	min 2000	min 1500	min 1500
Vitamin E – α-tocoferol (mg.kg^{-1})	min 20.0	min 20.0	min 20.0
Vitamin B_2 (mg.kg^{-1})	min 8.0	min 6.0	min 6.0
Vitamin B_{12} (μ.kg^{-1})	min 30.0	min 20.0	min 20.0

All pheasants were caught on common hunting in the hunting area of M VI Nitra in accordance with the **Hunting Act of Slovak Republic no. 274/2009 Coll.** and **72/2012 Coll**. individuals were hunting during the month of December 2017. The hunters respected the **Regulation (EC) No 853/2004** and **No 854/2004** during the hunting. There was a natural cooling of the pheasants. After hunting, the animals were stored for 24 hours in a refrigeration apparatus at 4 °C. Subsequently, the skin with the feathers was removed and samples of breast muscle were taken to perform the oxidative stability analysis. The first analysis was performed after 1 day of hunting. Other samples were stored 6 months at the temperature -18 °C after first analysis and after this period were carried out analysis.

Determination of fat contents

The basic chemical composition analyses including the fat content was carried out by FoodScan LAB Analyzer (FOSS, Denmark). The homogenized sample of meat – *musculus pectoralis major* was analysed by NIR (Near infrared technology, USA) technology with monochromator working with 850 – 1050 nm wavelengths. The fat content was calculated as g.100 g^{-1} in wet *musculus pectoralis major*.

Determination of MDA contents

The content of MDA was determined according **Marcinčák *et al*. (2004)**. For analysis we used UV VIS spectrophotometer Jenway 7305 (United Kingdom - JENWAY). The samples and standards were measured at a wavelength 532 nm. After constructing the calibration curve was calculated results will as the mg of MDA in 1 kg of sample.

Statistical analysis

Obtained results were carried out according to Statistic Analysis System SAS software with the Enterprise Guide 4.2 application (version 9.3, SAS Institute Inc., USA, 2008). We used the nonparametric Wilcoxon´s t-test for comparison of two independent sets of data.

RESULTS AND DISCUSSION

The results of breast muscle fat contents of farm-rearing and free-rearing are shown in Table 2. Based on the obtained results, we found higher fat contents in farm-rearing pheasants (1.73 g.100 g^{-1} - male, 2.23 g.100 g^{-1} - female) than in free-rearing pheasants (1.43 g.100 g^{-1} male 1.62 g.100 g^{-1} female). From the statistical aspect we have found statistical differences (P≤0.05) between sex in farm-rearing as well as free-rearing pheasant, and also a comparison (P≤0.05) of

pheasant female and male between monitored rearing. The fat content found in pheasant breast by **Slamečka *et al*. (2003)** was 1.17 g.100 g^{-1}. **Kováčiková *et al.* (2001)** report higher results etc. 3.33 g.100 g^{-1} of fat contents in pheasant breast muscle, on the contrary, **Tucak *et al*. (2008)** who report that a fat contents in the breast muscle was only 0.6 g.100 g^{-1} and **Golze (2010)** 1.0 g.100 g^{-1}. **Vitula *et al.* (2011)** report fat contents in pheasant farm-rearing 1.86 g.100 g^{-1} resp. 4.66 g.100 g^{-1} fat in dry matter. **Večerek *et al*. (2005)** report fat contents of breast muscle in 70 days of age pheasants 2.38 g.100 g^{-1} in farm-rearing. Fat content monitored by **Haščík *et al.* (2010)** were 1.27 g.100 g^{-1} in female and 1.06 g.100 g^{-1} in male pheasants from farm-rearing.

Table 2 The comparison of fat contents (g.100 g^{-1}) in *musculus pectoralis major* in farm-rearing and free-rearing pheasants

Group	Sex	means	SD	SE	P-value
Farm rearing	Male	1.73^{aB}	1.17	0.053	
	Female	2.23^{bB}	0.409	0.129	< 0.0001
Free-rearing	Male	1.43^{aA}	0.086	0.027	
	Female	1.62^{bA}	0.170	0.054	< 0.0001
P≤0,05		Farm Male : Free Male 0.0001		Farm Female : Free Female 0.0010	

Legend: Data are reported as mean – arithmetic average, SD - standard deviation, SE - standard error, a,b means with different superscripts in the same column are significantly different (P≤0.05) between one type of rearing; A,B means with different superscripts in the same column are significantly different (P≤0.05) between male or female

The TBARS test (contents of MDA) is an available indicator of meat lipid peroxidation (**Gamal *et al*., 2003; Hussein and Selim, 2018**). In our experiment, we compared the MDA contents in the *musculus pectoralis major* pectoral muscle at the beginning of storage and after the 6 months of storage. The concentration of malondialdehyde (mg.kg^{-1}) in meat of pheasant at the start of storage is shown in Table 3. At the beginning of storage, the lowest concentrations of MDA were found in female pheasants from free-rearing (0.025 mg.kg^{-1} MDA). Approximately the same values were recorded between male and female from free-rearing. There were also no significant differences (P≥0.05) between groups at the beginning of storage.

Table 3 The comparison of malondialdehyde concentration (mg.kg^{-1}) in *musculus pectoralis major* of pheasant at the start (1st day) of storage

Group	Sex	Mean	SD	SE	P-value
Farm rearing	Male	0.049	0.015	0.003	
	Female	0.056	0.016	0.003	NS
Free-rearing	Male	0.037	0.035	0.008	
	Female	0.025	0.018	0.0059	NS

Legend: Data are reported as mean – arithmetic average, SD - standard deviation, SE - standard error, NS – non significant differences (P≥0.05)

At the beginning of storage were recorded the highest values of MDA in male (0.049 mg.kg^{-1}) and female 0.056 mg.kg^{-1} from farm-rearing, which also corresponds to higher fat contents in breast muscle of farm pheasants between male and female for farm-rearing and free-rearing pheasants.
During the storage period (Table 3, 4), the contents of MDA in female pheasant breast muscle increased in farm-rearing from 0.056 to 0.197 mg.kg^{-1} and for male from 0.049 to 0.113 mg.kg^{-1}. We found lower MDA values during storage in free-rearing pheasants (female – from 0.025 to 0.150 mg.kg^{-1} and in male from 0.037 to 0.137 mg.kg^{-1}).

There were significant differences (P≤0.05) between sex at the beginning and at the end of storage in contents of MDA in farm-rearing and there were no significant differences (P≥0.05) between sexes in free-rearing pheasants.
We found significant differences (P≤0.05) only in hens by comparing between the same sex of farm-rearing and free-rearing pheasants at the end of storage period in the breast muscle.

Table 4 The concentration of malondialdehyde (mg.kg^{-1}) in meat of pheasants at the end (6st month) of storage

Group	Sex	Mean	SD	SE	P-value
Farm rearing	Male	0.113^{a}	0.035	0.010	
	Female	0.197^{bA}	0.048	0.013	<0.0001
Free-rearing	Male	0.137	0.056	0.009	
	Female	0.150^{B}	0.064	0.011	NS

Legend: Data are reported as mean – arithmetic average, SD - standard deviation, SE - standard error, a,b means with different superscripts in the same column are significantly different (P≤0.05) between one type of rearing; A,B means with different superscripts in the same column are significantly different (P≤0.05) between male or female

Compared to our results **Bobko *et al.* (2015)** founded contents of malondialdehyde during storage in chicken breast at 6th month (0.157 mg.kg^{-1}). At the beginning of storage contents of malondialdehyde was 0.106 mg.kg^{-1}. The contents of MDA was also investigated by **Marcinčák *et al.* (2008)**, where, however, at the beginning of the study period, the values in breast in chicken were 0.14 mg.kg^{-1} and after 6 months of storage in freezer 0.184 mg.kg^{-1}. Similar values were achieved by **Haščík *et al*. (2011)** 0.065 mg.kg^{-1} contents of MDA in chicken at the start of the experiment and however, at 6 months of storage it was only 0.137 mg.kg^{-1} in the breasts of broilers, which is consistent with the results of our experiment.

CONCLUSION

Pheasant meat has a very interesting dietary value. In Slovakia, the consumption of pheasant meat is increasing as from free-rearing or farm-rearing. Because of the lower fat contents in pheasants from free-rearing, we also observed lower contents of MDA against in farm-rearing pheasants. However, compared to chickens, a faster oxidation can be observed in pheasant from free-rearing. This experiment needs to be continued to confirm this trend.

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