Some chemical and physical characteristics of farmed pheasant hens (*Phasianus cholchicus*) breast meat

Csaba FERNYE – Márta ERDÉLYI – Zsolt ANCSIN – Andrea BÓCSAI – Miklós MÉZES

Szent István University, Faculty of Agricultural and Environmental Sciences, Department of Nutrition, H-2103 Gödöllő, Páter Károly u. 1., Hungary; E-mail: fernye.csaba@gmail.com

Abstract: Ring necked pheasant is the most significant game bird in Hungary. Around 300.000 pheasant harvested (hunted) annually and generally these birds are consumed by the hunters. As there are limited data on the quality of pheasant meat, in the present study we aimed to analyze some physical and chemical properties of it. At 20 weeks of age 63 pheasant hens were exterminated by cervical dislocation and meat, liver, spleen and heart samples were taken. The live weight of the birds was 1045±92g (870 to 1300g). The average weight of the liver, spleen and heart was 14.12±2.58, 0.47±0.13 and 4.30±0.49, respectively. The average drip loss was 5.90±2.38% (0.68±0.28g). As was expected the average protein content (26.2±0.7%) of the pheasant breasts was markedly higher than in broiler or turkey. The average fat content (0.4±0.2%) was similar to that in turkey. The unique chemical and physical properties of the pheasant meat make it suitable to fit in the human nutrition.

Keywords: pheasant, tenderness, drip loss, colour, chemical composition

Introduction

Ring necked pheasant is the most significant game bird in Hungary with the estimated population of 630.435 individuals (Csányi *et al.* 2016). Around 300.000 pheasants are harvested (hunted) annually, and most of them are consumed by the hunters. It is a widespread opinion that game meat has high protein, but low fat content (Aidoo and Haworth 1995; Crawford 1968). It also has to be highlighted that chemical composition of meat is not a constant attribute, but is known to be affected by season (Smankó *et al.* 2007), gender (Piaskowska *et al.* 2015; Purchas *et al.* 2010), age (Dannenberger *et al.* 2013) and type of muscle (Razmaité *et al.* 2015).

However, there is only limited information available on the chemical composition of pheasant meat. According to the results of Straková *et al.* (2011) 93.72 % protein and 2.95 % fat were present in the breast meat on dry matter bases, while the thigh had 78.18 % protein and 16.37% fat content. The same parameters on wet matter bases are between 20.73% protein and 0.13% fat for the breast, while 25.66% protein and 3,9% fat for the thigh, respectively (Severin *et al.* 2006; Hofbauer *et al.* 2010; Franco and Lorenzo 2013). These parameters can vary between farmed and wild pheasants, as well. According to Saeki and Kumagai (1990) and Tucak *et. al.* (2004, 2008) the meat of the farmed pheasant contains less protein, but more fat, compared to the wild birds. On the other hand, Hofbauer *et al.* (2010) did not confirm these differences between the wild and farmed pheasants. Even less data are available about the physical characteristics of pheasant meat, such as color, pH, water holding capacity and tenderness. Similarly to the meat of slaughtered animals (Fletcher, 1999; Bendall, 1988; Mach *et al.* 2008) pheasant meat has a slightly acidic pH (5.66-6.03) (Hofbauer *et al.* 2010). The drip loss ranges from 1 to 3% and an average of 30 N/cm^2 shear force characterizes the tenderness (Hofbauer *et al.* 2010).

The purpose of the present study was to provide further data on the chemical and physical attributes of farmed pheasant hen breast meat.

Materials and methods

Housing and feeding

A total of 63 pheasant hens at 16 weeks of age were kept in an aviary with 2 m^2/bird stocking density for 4 weeks. Feed and water were provided *ad libitum*. The feed was supplied in mashed form, and its guaranteed chemical composition (Vitafort Zrt. Dabas) is presented in Table 1.

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Table 1. Chemical composition of the diet

Metabolisable energy (MJ/kg)	10.69
Crude protein (g/100g dry matter)	19.34
Crude fat (g/100g dry matter)	2.90
Crude fiber (g/100g dry matter)	4.10
Crude ash (g/100g dry matter)	7.20
Lysine (g/100g dry matter)	0.95
Methionine (g/100g dry matter)	0.45
Ca (g/100g dry matter)	1.02
P (g/100g dry matter)	0.70
Na (g/100g dry matter)	0.15

Sampling

At 20 weeks of age individual live weight of the pheasants was measured. Then the birds were exterminated by cervical dislocation and exsanguination and *post mortem* meat, liver, spleen and heart samples were taken, and their weight was determined. Besides absolute organ weight, relative weight of the organs was also calculated, to normalize the variability due to different body weight. The physical and chemical characteristics of the meat were determined in the breast (*m. pectoralis major*) of the birds. For chemical analyses and tenderness measurements the samples were stored at -20°C until analysis, while the other measurements were made on fresh or chilled (4°C) samples.

Physical characteristics

The pH, colour and water holding capacity were tested on meat samples from 43 pheasants. After the slaughter both pectoral muscles (left and right) were removed from the carcass. The left muscles were tested for pH and colour, while the right muscles were used to determine the water holding capacity.

Measurements of the pH were carried out with WTW pH 330 (Weilheim, Germany) sensor simultaneously with colour measurements.

Water holding capacity (WHC) is normally described with drip loss analysis. For this purpose the small pectoral muscle (*m. pectoralis minor*) was removed from the right breast and modified Honikel (1998) method was used to determine weight loss. Thus the samples were pierced and hanged in the fridge at 4 °C and left there for 96 hours. Weight of the samples was measured at hanging (0) and 96 hours later and drip loss was calculated accordingly (Lesiak *et al*. 1995).

Objective colour analysis was done with Minolta CR-300 chromameter on the fresh cut surface of the muscles at 0 and 36 hour *post mortem*. This device works with reflectance spectrometry and the evaluation was done with the use of CIELAB (Commission Internationale de l'Eclairage, Paris, France, 1976) coordinates of lightness (L*), redness (a*) and yellowness (b*). For tenderness analysis the left pectoral muscle of 20 separate birds were taken (the same bird were used in chemical analysis). After weighing, the muscles were fried in an electric contact griller until their core temperature reached 72°C. Tenderness was tested on the grilled meats after a short cool-down period (until the samples reached room temperature). The samples were cut into prismatic slices with a cross section of 1cm^2. The slices were tested with a TA.XT. plus Texture Analyser (Stable Micro Systems, Godalming, United Kingdom) attached with a Warner-Bratzler device. The shear blade (1.016 mm thick) had vee-shaped 60° angle. The blade was moving with 2 mm/sec speed. Three cuts were made on each muscle prism and the mean value of the cuts was recorded.

Chemical composition

Due to the number of different tests the samples for chemical analysis (and tenderness) had to be taken from 20 separate pheasant hens. After slaughtering the right pectoral muscle was removed, packed in plastic bags, and stored at -20^{o}C for further processing. Before analysis, the samples were thawed to room temperature and all visible adipose and connective tissue was cut away, then the meat was ground and homogenized. Dry matter content was measured by drying at 105°C up to constant weight (MSZ ISO 1442 - 2000). The crude protein content was determined with Kjeldahl method (MSZ 5874/8-78). Soxhlet extraction with hexane as solvent (MSZ ISO 1443-2002) was used for the total lipid content analysis, while ash content of the meat was measured with incineration at 550 °C to constant weight (MSZ ISO 936).

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Statistical analysis

Correlation coefficient for pH and drip loss was generated using the Pearson's Correlation Coefficient in GraphPad InStat 3.05 software (GraphPad Software, San Diego).

Results and discussion

Physical characteristics

The average live weight of the birds was 1045±92g (ranged from 870 g to 1300 g). In previous reports of Tucak *et al.* (2008) (970±157 g) and Hofbauer *et al.* (2010) (912±142 g) slightly lower weights were outlined, but accurate comparison is not possible, because the age and diet of the birds was not defined in those articles. However, Kuzniacka and Adamski (2010) found 978±10.5 g average live weight at 24 weeks of age using a finisher diet from the 17th week of growing period with higher energy, but somewhat lower protein content than in our investigation. The difference was only 67 g lower than in our investigation. Altogether, it can be said that growth performance of our pheasant hens can be considered as typical for the species.

The weight of the breast muscles was comparable to the earlier findings of Hofbauer et al. (2010), however, both the absolute (177.72±24.33 g) and the relative breast weight (17.70±2.22%) were markedly lower than those in the report of Tucak *et al.* (2008). The average weight of the liver spleen and heart were 14.12±2.58 g, 0.47±0.13 g and 4.30±0.49 g, respectively. Interestingly, in earlier studies Szabó *et al.* (2006; 2010) found different weights for liver and heart (18.6±2.29 g, 2.1±0.3 g respectively). However, these results have been found in adult males, and the age of the birds is not known. Other authors presented results about the weight of visceral organs together, such as "edible viscera" (Hofbauer *et al.* 2010) and "liver and heart" (Tucak *et al.* 2008) accurate comparison between these parameters can not be done. The only report available on female pheasants with separate organ weight was published by Straková *et al.* (2005), and they found 15.89 g for liver and 5.58 g for heart. Relative organ weights calculated from the data given in the cited article are 1.91% and 0.67% for liver and heart, respectively. In our experiment relative weight of liver was found to be 1.35% and 0.41% for the heart. Referred to the fact that the measurements of Straková *et al.* (2005) were done at 13 weeks of age, our results are considered to be below the literature data.

Considering quality traits of the breast meat, slight increase was found in the pH during the 36 hours of chilling period (Table 2.).

Table 2. Colour and pH values of the meat samples 0 and 36 hour post mortem (n=43)

	L* (Lightness)	a* (Redness)	b* (Yellowness)	pH
0h	49.27±4.25	5.84±2.17	6.55±1.90	5.52±0.14
36h	48.53±3.82	5.61±1.78	7.59±2.74	5.67±0.19

However, even after culling the pH was as low as 5.52 and remained below 6.0 after 36 hours of storage. This data is important, because it is known that when the pH is lower than 6.0 the muscle protein denaturation may increase. The pH values found in our investigation were similar to those of Kokoszynski *et al.* (2012) for 16-week-old hens (5.87±2.60) or by Hofbauer *et al.* (2010) for pheasant (5.55±0.16). This pH range, between 5.6 to 6.0 is considered to be normal for raw poultry meat (Fletcher, 1999). The average weight of the small pectoral muscles was 11.87±2.78 g and the average drip loss was 5.90±2.38% (0.68±0.28 g), which is notably higher as was found by Hofbauer *et al.* (2010) in pheasant (2.19±1.37%). Corresponding values were found in pale broiler breast fillets (Woelfel *et al.* 2002) and turkey breast stored at high temperature (30^0C) (Lesiak *et al.* 1996). According to the results of Hofmann (2004) the lower pH in the muscle has correlation with higher drip loss during storage. There was a moderate negative correlation ($r = -0.4421$) between the pH and drip loss of the meat samples ($p < 0.01$). However, other factors may also contributed resulting higher drip loss such as stress during the handling and slaughtering. Game meats are typified with a deeper red colour than that of the meat of other livestock animals. Our results (Table 2) partially confirmed this concept as - even with the dominant yellowness (b*) -

the redness (a*) values were markedly higher than in broiler meat (Allen *et al.* 1997; Fletcher 1999). Turkey meat however poses similar redness; while its yellowness is considerably lower (Fraqueza *et al.* 2006). However, the average redness (a* value) was slightly higher than in other pheasant hens (Hofbauer *et al.* 2010). Considerably higher red (a* 16.5 and 18.1) values were revealed in different genetic groups of pheasants at 16 weeks-of-age by Kokosznynski *et al.* (2012), while lightness (L*) and yellowness (b*) values were similar.

According to the shear force results (2.62±0.93kg) of present study, the pheasant meat was found to be slightly less tender than the broiler chicken (1.98-2.10 kg) (Castellini *et al.* 2002) or the turkey meat (1.69 kg) (Ngoka *et al.* 1982). However, our result was still below as compared to previous literature data for the tenderness of pheasant meat as 2.9-3.2 kg value as was reported Hofbauer *et al.* (2010). These characteristics could be hypothetically attributed to the higher proportion of connective tissue, and increased heat stable cross-links between collagen fibrils and subsequent tensile strength in different species and ages (Owens *et al.* 2004).

Chemical composition of meat

As was expected, the average protein content (26.2±0.7%) (Table 3.) of the pheasant breasts was markedly higher than in broiler chicken (Castellini *et al.* 2002) or turkey breasts (Ngoka *et al.* 1982). The average protein value in our study was even higher than in the earlier studies (25.38±0.68 and 25.03±1.08 respectively) of Tucak *et al.* (2008) and Hofbauer *et al.* (2010). Hofbauer *et al.* (2010) mentions that higher protein content can be associated with higher dry matter (lower moisture content) and lower fat content. In our case, the dry matter content (27.2±0.5%) of the samples was even lower than the values found by other authors. The average fat content (0.4±0.2%) was similar to that in turkey (Ngoka *et al.* 1982) and it was in accordance with the earlier findings of Hofbauer *et al.* (2010) and Straková *et al.* (2011) in pheasant. According to the latter literature, the reported chemical composition of pheasant meat showed 5.16% higher protein and 55.3% lower fat content compared to broiler chicken breast meat. There is a notable difference in the crude ash content, as well. Our results (1.9±0.4%) were almost two times higher than in other pheasants (Tucak *et al.* 2008) or turkey (Ngoka et al. 1982) and three times higher than in broiler chicken (Castellini *et al.* 2002). However, ash content of pheasant meat is normally similar or even lower than that of the broiler meat (Straková *et al.* 2011; Hofbauer *et al.* 2010).

Table 3. Chemical composition and tenderness properties of pheasant meat (n=20)

	Mean	SD
Shear force (kg)	2.62	0.93
Dry matter (g/100g)	27.2	0.5
Crude protein (g/100g)	26.2	0.7
Crude fat (g/100g)	0.4	0.2
Crude ash (g/100g)	1.9	0.4

Conclusions

Quality of game meat is normally different than that of other livestock meat. Only a few data are reported in the literature on sensory value and chemical composition of pheasant meat. Furthermore, intrinsic (age, sex, genotype) and environmental factors (feeding, housing, culling) are quite different in the various experiments, therefore no consistent meat quality data are available and our results might help to determine the normal range for certain sensory properties and macronutrient content of the pheasant meat.

Our results mostly agree with the previous findings of Hofbauer *et al.* (2010), except a major difference in the shear force and ash content among the analysed parameters. However, high level of discrepancies were found when our data were compared with other literature sources (Franco and Lorenzo 2013; Straková *et al.* 2005). These variances might be at least partially due to the different age of birds, and the different growing, feeding and slaughtering conditions.

Considering the sensory parameters pheasant meat shows major difference from that of the intensive poultry species. Drip loss was much

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higher and as juiciness of the meat is determined by its water holding capacity, juiciness is poor for pheasant meat. This finding agrees with the results of tenderness analysis, with higher shear force. Finally, our colour results have confirmed that game meat is more red than the meat of other domesticated avian species.

It was proven in our experiment, that pheasant breast meat has low fat and high protein content. However, crude ash data are quite contradictory. To clarify the reason of the variance among the different literature data further research is to be done. Altogether, pheasant meat is different in its sensory attributes and chemical composition from the meat of commercial poultry species, but it is a good candidate to fit in the human nutrition as it has good protein, low fat content and preferable red colour. To increase its consumption further analysis of quality traits and the influencing factors is needed.

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