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Original Paper

Basic chemical composition analysis of farmed Common pheasant (*Phasianus colchicus* L.) venison

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The high dietetic value of common pheasant venison is revealed in many researches. The aim of that paper was to evaluate the basic chemical composition of farmed pheasant venison. Protein, collagen, fat and water content in skinned meat of both sexes were subjected to analyses. Different body portion as breast muscle and leg muscle were compared as well. FoodScan LAB Analyzer was used to determine the evaluated meat traits. Significantly higher content of collagen and fat was observed in leg meat, comparing to breast portion due to the structure of meat. Contrary, expressive differences were detected in content of protein and water, with significantly higher values in breast portion. The cock´s meat shows higher content of collagen and water comparing to hen´s meat while hens show higher content of fat. The content of protein shows only small differences between sexes.

Keywords: Common pheasant, venison, nutrients content

1 Introduction

Common pheasant (*Phasianus colchicus* L.) is a typical representative of bird game. Currently the Common pheasant is the most abundant, widespread and economically important non-migratory game bird in Europe. Its production presents more than 40% of all game bird hunted in Europe (CABS, 2010). Besides the interest of hunting the pheasant venison seems to be a very popular kind of meat as well. The poultry production is one of the most intensively developing branch of farming (Genchev et al., 2008). The increasing production of meat in general is leading to diversify the product range. So the networks offer some new products such as meat from quails, ostriches, and pheasants. However pheasant´s meat is consumed relatively rarely in comparison with poultry meat, pork or beef (Chisholm et al., 2008). A lot of authors suggest that there is only one of free range living species of *Phasianus* genusthat can be potentially used to produce meat of high quality (Marsico & Vonghia, 1992; McGowan & Garson, 1995). The common pheasant (*Phasianus colchicus* L.) is the most important game specie of landfowls due to the major rate of hunted birds (CABS, 2010). According to Straka and Malota (2005), a slightly different distribution of proteins in the pheasant venison influences the characteristic taste of the bird meat. Apart from high gustative values the meat is also very soft and juicy (Dronca, 2008). Numerous studies have shown the slaughter yield and also basic chemical composition of pheasant meat (Richter et al., 1992; Tucak et al., 2008). The protein content in pheasant venison ranges from 20 to 25 g 100 g^{-1} with slightly higher level in breast muscle. The content of fat varied from 0.8 to almost 7 g 100 g^{-1} with expressive higher level in leg muscle. Water content ranges at the level 71 to 73 g 100 g^{-1} (Kuzniacka et al., 2007; Tucak et al., 2008; Biesiada-Drzazga et al., 2011; Katowicz et al., 2012). Pheasant meat, as a white meat is considered to be meat of high protein and low fat content (Biesiada-Drzazga et al., 2011), interesting proportion of essential and unsaturated fatty acids and a high content of vitamins of group B (Večerek et al., 2005). Though the Common pheasant can be considered to be a specie of great potential to produce high quality meat (Marsico & Vonghia, 1991), the most countries carry out the hunting management of that specie, due to the higher economical contribution (Quaresma et al., 2016). The aim of the paper was to determine the basic

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chemical composition of farmed pheasant as collagen, fat, water and protein content and compare the content of that nutrients in different body parts.

2 Material and methods

2.1 Animals and housing

The experiment was carry out with the typical representative of Pheasant genus the Common Pheasant (*Phasianus colchicus* L.). The tested animals were reared in artificial conditions at the pheasant farm respecting the general rules of artificial production. The pheasant´s eggs were hatched in incubator. The hatched animals were housed in closed room with controlled breeding condition until the age of 8 weeks. Completely feathered animals were moved to wire aviary after the rearing phase of artificial conditions and they consequently were hold in the aviary up to the time of hunting. Experimental animals were hunted in December 2018 according to the Act no. 274/2009 Coll. on Game management and Ordinance no. 344/2009. 10 cocks and 10 hens in the age of 6 months were subjected to analyses.

2.2 Feeding programme

Chickens in the age from one day to three weeks were fed *ad libitum* the complete diet for young chickens BŽ 1. The youngs from the age 3 weeks up to the 7th week of age were fed *ad libitum* the complete diet BŽ 2. In the age from the 7th to the 10th week of the age as the transitional period was fed the BŽ 2 diet combined with wheat grains. Only grains were fed to the animals from the 10th week of their age. The grain feeding was based on the wheat, with smaller (up to 20%) content of maize and sunflower seeds that take place in fed during the winter months.

2.3 Carcass processing and analyses

The hunted game was chilled in natural conditions during the hunt and eviscerated according to European rules (Janto et al., 2013). The skinned carcasses were consequently storage in the fridge in the controlled temperature up to 4 °C for 24 hours. The specimen processing take place after the process of venison aging. Skinned and boned *Musculus pectoralis major* as the breast and thigh mucles of *musculus iliotibialis* group as well as thigh muscles of *musculus iliotrochantericus* group as the leg samples were analysed in the experiment. The basic chemical analyses were carry out at FoodScan LAB Analyzer (FOSS, Danmark). Content of collagen, fat, water and protein was monitored in the experiment.

2.4 Statistical analyses

The content of collagen, water, fat and protein in breast and leg muscle were subjected to statistical analyses. Arithmetic means, standard error of mean, minimum and maximum were calculated. The two factor analysis of variance, calculating the effect of the muscle and the sex on the pheasant meat composition was investigated. The relations of each analysed component were calculated with the use of Pearsons coefficient of correlation. The level of significance was at $p < 0.05$ for both analyses. All the calculated statistical analyses were made with the use of software of Statgraphic Centurion 18®.

3 Results and discussion

3.1 Collagen content

Statistical analyses of collagen content are shown in table 1. The content ranges from 0.56 ±0.18 g 100 g^{-1} in cock´s breast to 1.38 ±0.75 g 100 g^{-1} in cock´s leg. Differences between muscle groups were found up in collagen content. The legs muscles of both sexes show higher collagen content comparing to breast muscles, while the cock´s legs show the significantly ($P = 0.0021$) higher content of collagen ever. Within sex differences of collagen content were detected as well, while no significant difference was count in breast muscle. The higher collagen content of the thigh muscles comparing to breast muscles was detected due to the different morphological structure and physiological function of breast and leg muscles. Breast portion is composed by two muscles pectoralis major and minor, while leg encloses several different muscles (in both thigh and drumstick) that leads to higher share of tissues rich of collagen as fascial walls and tendons.

Table 1 Collagen content in experimental groups

Muscle	Cocks		Hens	
	breast	leg	breast	leg
CC (g 100 g^{-1}) ±S.D.	0.56 ±0.18^{a}	1.38 ±0.75^{b}	0.52 ±0.11^{a}	0.80 ±0.75^{a}
Min (g 100 g^{-1})	0.30	0.63	0.32	0.17
Max (g 100 g^{-1})	0.83	2.28	0.74	2.28

CC – mean for collagen content, S.D. – standard deviation, Min – minimal value, Max – maximal value, a, b – different letters in each row indicates statistically significant differences at the 95.0% confidence level ($P = 0.0021$)

A different number of collagen content with 1.7 and 1.8 g 100 g^{-1} in cocks and hens respectively are shown in research of Kokosinski et al. (2018). No differences of collagen content in breast and leg meat muscles were detected contrary to our findings. A very meagre information of collagen content in pheasant´s meat is available.

3.2 Fat content

The individual fat content varies from 1.39 g 100 g^{-1} to 8.29 g 100 g^{-1} in cock´s breast and hen´s leg respectively. Significantly higher contents of fat were detected between the sex groups and between the muscles groups as well, with higher content detected in hens and thigh muscle. The cock´s breast shows to be a very lean muscle with the fat content 1.67 ±0.22 g 100 g^{-1} comparing to 5.27 ±0.87 g 100 g^{-1} in the cock´s leg. The difference shows to be significant (P <0.05). The fat content in hen´s breast (2.18 ±0.43) was shown significantly smaller comparing to hen´s leg muscle (6.48 ±1.20) analogically. The differences were detected at the 95.0 confidence level and the P-value was calculated P = 0.000 for fat content analyses.

Quaresma et al. (2016) find out the fat content in pheasant´s breast muscle 1.30 vs. 3.46 g 100 g^{-1} in leg muscle, with highly significant (P <0.001) differences, while the sex was determined as factor non influencing the fat content in muscle. Our presented differences in the fat contents of breast and leg meat are in agreement with results of Franco and Lorenzo (2013); Hofbauer et al. (2010); Nuernberg et al. (2011); USDA (2014), while the breast venison is always the leaner meat comparing to leg meat. The lower content of fat in breast muscle portion comparing to leg is the expression of different amounts of intramuscular fat deposited in different body portion as like as the composition of muscle fibres type of each part. While the breast muscle contains from fast-twitch glycolytic fibres using the glycogen as primal energy source, the leg muscles are mainly composed by slow-twitch oxidative fibres, using the lipids as the energy stores (Quaresma et al., 2016).

Our findings, 1.67 g 100 g^{-1} in cock´s and 2.18 g 100 g^{-1} in hen´s breast present higher values of fat content in analysed muscle groups comparing to other research. Franco and Lorenzo (2013) presented average fat content in breast muscle 1.3 g 100 g^{-1}, Tucak et al. (2008) detected in farmed pheasants the breast fat content 1.15 and 1.69 g 100 g^{-1} in cocks and hens and the lowest number of intramuscular fat content was detected 0.5 and 0.7 g 100 g^{-1} by Kokosinski et al. (2018) or 0.35 and 0.52 g 100 g^{-1} by Hofbauer et al. (2010) in cocks and hens respectively. Similarly, the thigh muscle fat contents of 5.27 to 6.48 g 100 g^{-1} is excessively higher comparing to values 3.2 – 4 g 100 g^{-1} determined by Quaresma et al. (2016); Franco and Lorenzo (2013); Hofbauer et al. (2010); Nuernberg et al. (2011) or 2.31 – 2.78 g 100 g^{-1} presented by Kuzniacka et al. (2007). The lowest values of intramuscular fat level in leg muscles show Kokosinski et al. (2018) as 1.2 to 3.0 g 100 g^{-1}. Vice versa, Tucak et al. (2008) present the highest content varying from 6.62 to 6.81 g 100 g^{-1}. Our results are in range of values detected in presented papers. High variability of results shown previously indicates that this trait can be expressively influenced by endogenous factors as like as exogenous factors like nutrition and feeding system. Finally, the fat content is strongly influenced by the mode of dressing and processing (Hofbauer et al., 2010).

3.3 Water content

The basic characteristics of water content are shown in table 3. Significantly higher content (P <0.05) of water was detected in breast muscle comparing to leg muscle in both sexes. The individual water content in experimental groups varies from 72.26 to 67.80 in cock´s breast and hen´s leg respectively. Between sex comparison shows slightly higher content of water in cock´s venison comparing to hens with significant differences detected (P = 0.000). All values detected in the experiment shows low level of variability while all average water percentages reach value close to 70 g 100 g^{-1}.

Similar results are presented by Tucak et al. (2008), showing higher water content in cocks, comparing to hens and the higher content of water in breast muscles comparing to leg muscles. The values of water content varied from 71.42 in hen´s leg to 72.61 g 100 g^{-1} in cock´s breast. Our results are in accordance with numbers 69.9

Table 2 Fat content in experimental groups

Muscle	Cocks		Hens	
	breast	leg	breast	leg
FC (g 100 g^{-1}) ±S.D.	1.67 ±0.22^{a}	5.27 ±0.87^{b}	2.18 ±0.43^{a}	6.48 ±1.20^{c}
Min (g 100 g^{-1})	1.39	4.31	1.53	4.71
Max (g 100 g^{-1})	1.94	7.34	3.07	8.29

FC – mean for fat content, S.D. – standard deviation, Min – minimal value, Max – maximal value, a, b, c – different letters in each row indicates statistically significant differences at the 95.0% confidence level (P = 0.000)

Table 3 Water content of experimental groups

Muscle	Cocks		Hens	
	breast	leg	breast	leg
WC (g 100 g^{-1}) ±S.D.	71.55 ±0,59^{a}	70.77 ±0.56^{b}	70.64 ±0.81^{b}	69.00 ±1.00^{c}
Min (g 100 g^{-1})	70.46	69.63	69.31	67.80
Max (g 100 g^{-1})	72.26	71.62	71.65	70.80

WC – mean for water content, S.D. – standard deviation, Min – minimal value, Max – maximal value, a, b, c – different letters in each row indicates statistically significant differences at the 95.0% confidence level (P = 0.000)

Table 4 Protein content of experimental groups

Muscle	Cocks		Hens	
	breast	leg	breast	leg
WC (g 100 g^{-1}) ±S.D.	26.23 ±0.56^{a}	23.20 ±0.74^{b}	26.50 ±0.58^{a}	23.86 ±0.65^{c}
Min (g 100 g^{-1})	25.38	22.23	25.90	22.96
Max (g 100 g^{-1})	26.97	24.52	27.45	24.85

PC – mean for protein content, S.D. – standard deviation, Min – minimal value, Max – maximal value, a, b, c – different letters in each row indicates statistically significant differences at the 95.0% confidence level P = (0.000)

in hen´s leg to 72.2 g 100 g^{-1} in cock´s breast, with higher water content in cocks and breast muscle, comparing to hens and leg muscle respectively (Kokosinski et al., 2018). The studies presented previously show slightly higher content of water, comparing to our findings. That differences can by caused probably by the system of pheasant processing before the hunting preparation, when the birds were exposed to lack of the water for several hours, during the transfer to hunting ground. Contrary Kotowicz et al. (2012) shows water content in range of 71.5 to 74.1 g 100 g^{-1}, with higher values detected in hen´s breast comparing to cocks.

3.4 Protein content and correlations

The results of protein content analyses are shown in table 4. Significant differences were detected in protein content between breast and leg muscles in both sexes. The higher values are shown in cock´s breast and hen´s breast muscles 26.23 ±0.56 and 26.50 ±0.58 g 100 g^{-1}, comparing to 23.20 ±0.74 and 23.86 ±0.65 g 100 g^{-1} in cock´s leg and hen´s leg respectively. The differences in protein content are influenced by relations between other components, mainly that of fat content and collagen content.

The values 26.23–26.50 g 100 g^{-1} of protein in breast muscles presented in the paper are in range with the values 23.11–27.50 presented by Franco and Lorenzo (2013); Tucak et al. (2008); Kuzniacka et al. (2007) and Kokosinski et al. (2018). Slightly lower values of protein content in breast muscles of both sexes (21.9 vs. 21.9 g 100 g^{-1}) are presented by Kotowicz et al. (2012).

Higher content of protein in breast muscles comparing to leg muscles was detected in the experiment, the similar results are proved in researches of Tucak et al. (2008) 25.11–25.38 g 100 g^{-1} vs. 20.71–20.63 g 100 g^{-1}, Kokosinski et al. (2018) 25.7–27.5 g 100 g^{-1} vs. 23.1–23.2 g 100 g^{-1}, Biesada-Drzazga et al. (2011) 25.09 g 100 g^{-1} vs. 23.3 g 100 g^{-1}, Kotowicz et al (2012) 21.9 g 100 g^{-1} vs. 20.4 g 100 g^{-1} respectively. The differences of chemical composition between pectoral and thigh muscles shown in the paper are confirmed by observations of many researches including Faruga et al. (1975) and Straka and Simeonovova (2003). Absolutely highest content of protein (27.5 g 100 g^{-1}) was detected in the breast muscles of cocks by Kokosinski et al. (2018). No significant differences were obtained in breast muscle of both sexes that is in accordance with the results of Kuzniacka et al. (2007) and Tucak et al. (2008). Significant difference was detected in protein content of leg muscle, though only a very small difference was detected between sexes. So we can note, that the pheasant´s meat shows the sexual uniformity, regarding to chemical composition. Contrary, Macała (2008) notes, that quality of pheasant´s meat depends on the age and sex of the animals.

Correlations of subjected chemical traits of pheasant venison in general are shown in table 5. Significant correlations detected in the paper proves the mutual relations in basic chemical content of pheasant venison. The protein content is shown as the most variable trait of pheasant venison, due to the most significant correlations with other components. An expressive negative correlation was detected in relation to collagen and fat content (-0.4733 and -0.8463 respectively). That phenomenon is an expression of considerable different

Table 5 Correlation analyses of experimental groups

		Collagen	Fat	Water	Protein
Collagen	correlation		0.4174	-0.1622	-0.4733
	sample size		(40)	(40)	(40)
	P-value		0.0074*	0.3174	0.0020*
Fat	correlation	0.4174		-0.7257	-0.8463
	sample size	(40)		(40)	(40)
	P-value	0.0074*		0.0000*	0.0000*
Water	correlation	-0.1622	-0.7257		0.4218
	sample size	(40)	(40)		(40)
	P-value	0.3174	0.0000*		0.0067*
Protein	correlation	-0.4733	-0.8463	0.4218	
	sample size	(40)	(40)	(40)	
	P-value	0.0020*	0.0000*	0.0067*	

* - indicates statistically significant non-zero correlations at the 95.0% confidence level

structure of different body part´s muscles (Faruga et al., 1975; Straka & Simeonovova, 2003). As different body parts requires different functions of muscles, the final chemical compositions reflects the structural differences of muscles that were proved in the paper. Increasing volume of any component in each meat portion causes coherent decreasing content of any common meat nutrient, as shown in table 5. Similarly expressive negative correlation (-0.7257) was shown in relation of water and fat content. That fact is shown also in results of Tucak et al. (2008) and Kokosinski et al. (2018). Contrary, also positive correlation (0.4218) was detected in relation of protein content and water content in pheasant venison. That our result is at variance with the statement of Hofbauer (2010), who found out the positive association of higher protein content with the lower content of water in pheasant meat.

4 Conclusions

Basic nutritive components content were subjected to analyses in this paper. Influence of gender and meat portion on meat composition were evaluated. A few significant differences (95.0%) were associated with the sex effect in the study in all subjected nutrients. The body section seems to be a very important factor influencing the mutual chemical proportion of muscle due to the expressively different structure of body parts, subjected in this paper. The primal structure of muscles influenced the chemical composition of different carcass parts very expressively. The breast muscles show the highest protein content in both sexes, while the leg meat portion shows the highest percentage of fat, also with significantly higher volume in hens. Correlation analyses show relations between selected chemical components in pheasant meat. Positive, but mainly negative relations were detected in correlation analyses. Protein content is shown as the most variable parameter, because the protein content was expressively influenced by all basic chemical components monitored in the study.

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