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The selected histological traits of the pectoral muscle and basic slaughter values in crossbred geese

Wybrane cechy mikrostruktury mięśnia piersiowego powierzchownego oraz podstawowe wartości użytkowości rzeźnej gęsi mieszańców

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Abstract

The aim of study was to determine of basic values slaughter meat production and histological parameters of pectoral muscle in quadruple 24 weeks old crossbred geese. The hybrids produced using Graylag, White Koluda and Slovakian geese. The geese were divided to 4 groups differing crosses scheme. The body weight before slaughter was in the range from 4,752 g to 4,921 g, weight of carcass with neck from 3,101 g to 3,175 g and weight of breast muscles from 649 g to 698 g. Histological analysis of pectoral muscle showed that diameters of white fibers (αW) was in the range from 43 μm to 46 μm, red fibers (βR) from 19.4 μm to 22.1 μm. The percentage share of αW muscle fibers was in the range from 25.3% to 28.9%, βR fibers from 71.1% to 74.7%. The number of muscle fibers per unit area was in the range from 256 to 316 and intramuscular fat content from 3.9% to 6.7%. The results of evaluation of microstructural traits of *musculus pectoralis superficialis* and meat production parameters suggest that the breast muscles of the crossbred geese are raw material of high quality. The quadruple crossbred geese with graylag geese it is an alternative for production of high-quality meat.

Keywords: crossbred geese, graylag geese, histological traits, pectoral muscles

Streszczenie

Celem pracy było określenie podstawowych wskaźników użytkowości mięsnej i cech histologicznych mięśnia piersiowego 24-tygodniowych poczwórnych mieszańców gęsi. Mieszańce pochodziły z krzyżowania dzikiej gęsi gęgawej, Białej Kołudzkiej i Słowackiej. Gęsi przydzielono do 4 grup różniących się systemem krzyżowania. Masa ciała ptaków przed ubojem mieściła się w graniacach od 4 752 g do 4 921 g, masa tuszki patroszonej z szyją od 3 101 g do 3 175 g i masa mięśni piersiowych od 649 g do 698 g. Ocena histologiczna mięśnia piersiowego wykazała, że średnica włókien białych (αW) wynosiła od 43 µm do 46 µm, włókien czerwonych (βR) od 19,4 µm do 22,1 µm. Procentowy udział włókien αW mieścił się w granicach od 25,3% do 28,9%, βR od 71,1% do 74,7%. Ilość włókien na jednostce powierzchni mieściła się w granicach od 256 do 316, a udział tłuszczu śródmięśniowego wynosił od 3,9% do 6,7%. Wyniki oceny cech mikrostruktury *musculus pectoralis superficialis* i cech użytkowości mięsnej sugerują, że mięśnie piersiowe gęsi mieszańców są wysokiej jakości surowcem rzeźnym. Poczwórne mieszańce wytworzone z udziałem dzikiej gęsi gęgawy stanowią alternatywę w produkcji mięsa o wysokiej jakości.

Słowa kluczowe: cechy histologiczne, dzika gęś gęgawa, gęsi mieszańce, mięśnie piersiowe

Introduction

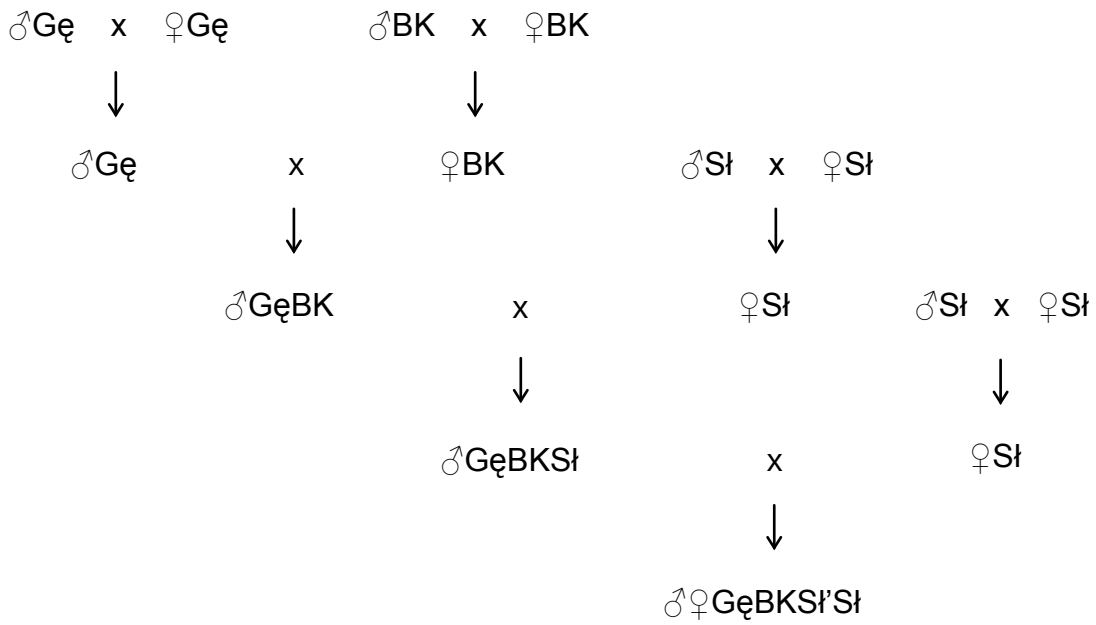
Long-term intensification of breeding in livestock production has resulted in the creation of breeds and synthetic lines characterized by a rapid rate of growth and high meatiness. However, this progress has had a negative effect on the quality of raw meat obtained from these animals. These changes are most often reflected in the occurrence of PSE (pale soft exudative) and DFD (dark firm dry) defects (Grajewska et al., 1984). However, high-lean and fast-growing animals are also affected by changes in the structure of muscle tissue, the major reservoir of valuable protein which forms the basis of the human diet. For this reason, studies are conducted to improve the quality of raw meat. Qualitative traits can be improved by crossing animals from closed populations with animals living in the wild. Filial generations like these usually have good slaughter traits and their meat is of better quality than the meat obtained from breeding animals (Chełmońska and Chrzanowska, 1996; Chrzanowska and Chełmońska, 2000; Mazanowski et al., 2002; Mazanowski and Dziadek, 2003). Chełmońska and Chrzanowska (1996) and Chrzanowska and Chełmońska (2000), who crossed White Koluda with wild greylag geese, obtained crossbreds with very good production parameters. Furthermore, raw meat obtained from these crossbreds was of better quality. In later studies (Mazanowski and Chełmońska, 2000; Mazanowski, 2001) Slovakian geese were crossed with wild greaylag hybrids. These animals are characterized by very good meat production parameters. In addition, histological analyses (muscle fibre diameters and proportion, percentage of intramuscular fat) of muscle tissue obtained from these animals showed that *pectoralis superficialis* muscles of these birds were of high quality (Walasik and Bogucka, 2005). In the next stages of the research, Mazanowski and Dziadek (2002) used replacement crossing with Slovakian geese.

The hybrids obtained were characterized by satisfactory meat and reproductive traits. For this reason, an attempt was made to make a histological evaluation of the quality traits of meat from quadruple crossbreds at cellular level.

Material and methods

Birds, housing and feeding

The experiment were performed on quadruple crosses of geese (80 animals) from replacement crossing with Slovakian geese. Birds were distributed one of four groups (10 females and 10 ganders) differing in the sequence of crossing parental components: I - GęBKSł'Sł, II – Sł'GęBKSł, III – BKGęSł'Sł, IV – Sł'BKGęSł. The crossing scheme showed Figure 1.



Explanation of symbols: Gę (Graylag geese), BK (White Kołuda geese), Sł (Slovakian geese).

Figure 1. An example of geese crossing

From 1 to 3 weeks of age the geese were fed standard mixture (17.91% crude protein, 11.98 MJ ME). Each 100 kg of the mixture contained vitamin preparations in the form of 35 mg of Polfomax Z and 20 g of Polfasol B compositium. From 4 to 6 weeks and from 7 to 12 of age the mixture was replaced with grass meal: 5% (17.66% crude protein, 11.54 MJ ME) and 10% (17.42% crude protein, 11.21 MJ ME) respectively. From 13 to 17 weeks, 20% of the mixture was replaced with 10% grass meal and 10% oats (16.51% crude protein, 11.1 MJ ME). From 18 to 24 weeks of rearing, 35% of the mixture was replaced with 15% grass meal and 20% oats (15.36% crude protein, 10.67 MJ ME). From 8 days to the end of rearing, geese were fed separately mineral mixture, chalk and gravel mixed with a 1:1:4 volume ratio. Crossbreds were reared from 1 to 24 weeks on rye straw under controlled environmental conditions with no access to free range. They were fed *ad libitum* in

keeping with waterfowl standards. At the 6th, 8th, 12th, 17th and 24th week of rearing all geese were weighed individually. At 24th weeks of age selected five males and five females of body weights close to the average weight for each group and slaughtered.

Histological analysis

Directly after slaughter, samples from right of the *pectoralis superficialis* muscle were taken and frozen in liquid nitrogen (-192 °C). Then samples were cut in Leica cryostat (-20 °C) on the 10 µm thick. These samples were used to make histological preparations, which were subjected to the following histochemical reactions (Dubowitz et al., 1973): NADH-TR activity (muscle fibre types: βR – red fibers with oxidative metabolism; αW – white fibers with glycolytic metabolism) with an adjustment of the preincubation fluid pH to 4.1 and Oil Red (proportion of intramuscular fatty tissue per unit area). Analysis of the microstructure of the *pectoralis superficialis* muscle was performed using a Q 500 MC microscopic image analysis system (Leica) and included the determination of percentages of muscle fibres differing in metabolism, their diameters in an area of 0.545 mm^2 (5 microscopic images), and the proportion of intramuscular fat tissue in an area of 2.178 mm^2 (20 microscopic images).

Statistical analyses

The results were analyzed with ANOVA module and included: means values, standard deviations and significance of differences between means using Duncan's multiple range test for $P<0.05$ (Statistica 6.0 PL software).

Results and discussion

Presented in Table 1 results of the selected traits in crossbred geese: body weight before slaughter, weight of carcass with neck and weight of pectoral muscles. The highest body weight were found in geese from group IV (4,921 g), the smallest from group III (4,752 g). The weight of carcass with neck was greatest in individuals from group I (3,175 g), the lowest from group III (3,101 g). The highest weight of breast muscles were found in birds from group II (698 g), while the lowest from group III (649 g). Analyzing the results included sex were found that males from group II showed the highest values for all traits: body weight before slaughter (5,444 g), weight of carcass with neck (3,612 g) and weight of pectoral muscles (808 g). Lowest body weight before slaughtered were found in males from group III (4,930 g), weight of carcass with neck and (3,261 g) and weight of pectoral muscles (676 g) ware found in males from group IV. The values of the most traits in ganders from group II were statistically significantly higher for $P<0.05$. In the females were found the highest values of all traits in geese from IV group: body weight before slaughter (4,788 g), weight of carcass with neck (3,068 g) and weight of pectoral muscles (667 g). The lowest values for all traits were found in individuals from group II: body weight before slaughter (4,198 g), weight of carcass with neck (2,687 g) and weight of pectoral muscles (589 g). The geese from IV group had statistically significantly

higher body weight before slaughter and weight of carcass with neck (P<0.05). The pectoral muscles mass did not significantly differences between the groups.

The quadruple crossbreed geese with graylag geese had lower body weight before slaughter, weight of eviscerated carcass with neck, weight of pectoral muscles compare with commercial White Koluda breed (Biesiada-Drzazga, 2014). The quadruple hybrids had also lower values mentioned production traits for crossbred produced using white Koluda and regional varieties of geese (Mazanowski, 2000). Mazanowski (2001) reported that preslaughter body weight, weight of eviscerated carcass with neck, weight of pectoral muscles and carcass fatness were higher in triple crosses in compare with own research results. Similarly Kowalczyk et al. (2013) also noticed that the crossing of wild and commercial breed goose causes a decrease of body weight before slaughtered, weight of eviscerated carcass with neck, weight of pectoral muscles and reduced carcass fatness in hybrids.

The quadruple crossbred geese with graylag geese despite of lower body weight before slaughter, weight of eviscerated carcass with neck, weight of pectoral muscles and carcass fatness it is an alternative for production of high-quality meat.

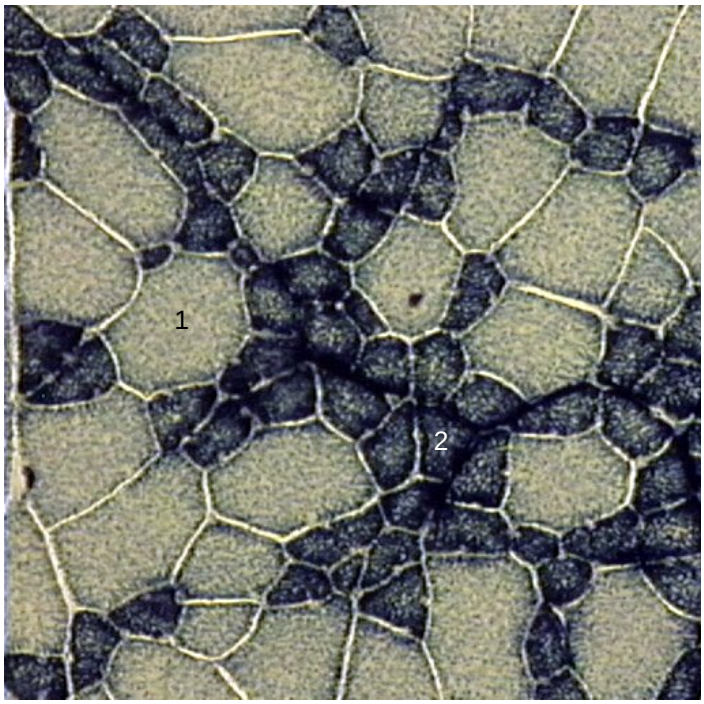
Table 1. Mean values ($\bar{x}$) and standard deviation (SD) of body weight, weight of eviscerated carcass with neck and breast muscles of 24-week-old crossbred geese

Group		Body weight before slaughter (g)			Weight of eviscerated carcass with neck (g)			Weight of breast muscles (g)		
		♂♀	♂	♀	♂♀	♂	♀	♂♀	♂	♀
I	$\bar{x}$	4,825	5,120^{b}	4,530^{a}	3,175	3,392^{ab}	2,958^{a}	689	731^{ab}	647
	SD	339	81.2	186	255	99.9	140	78.9	74.7	62.1
II	$\bar{x}$	4,821	5,444^{a}	4,198^{b}	3,149	3,612^{a}	2,687^{b}	698	808^{a}	589
	SD	665	139	87	509	184	122	140	109	49.1
III	$\bar{x}$	4,752	4,930^{b}	4,574^{a}	3,101	3,295^{b}	2,908^{ab}	649	700^{ab}	600
	SD	341	358	234	288	220	213	100	38.8	121
IV	$\bar{x}$	4,921	5,054^{b}	4,788^{a}	3,165	3,261^{b}	3,068^{a}	671	676^{b}	667
	SD	339	344	309	232	257	180	95.4	118	79.9

^{a,b}Mean values followed letters differ significantly (P<0.05).

Table 2 presents the results of histological analyses. The smallest diameters of both muscle fibres types and the lowest percentage share of red fibres (αW – 43 μm, βR – 19.4 μm; βR – 71.1%) as well as the largest percentage share of white fibres

(28.9%), the greatest number of fibres in the analyzed area (316.4) and the largest content of intramuscular fat (6.6%) were found in group III. White fibres diameters were the largest in animals from group IV (46 μm) and red fibres diameters in animals from group I (22.1 μm). The lowest percentage share of white fibres (25.3%) and intramuscular fat content (3.9%) was characteristic of animals from group II. In addition, this group was characterized by the largest percentage share of red fibres (74.7%). The number of fibres was the smallest in hybrids from group IV (255.5). The microstructure of *m. pectoralis superficialis* showed Figure 2.



1 – αW fibers, 2 – βR fibers.

Figure 2. Cross section of *m. pectoralis superficialis* quadruple crossbred geese

Table 2. Mean values ($\bar{x}$) and standard deviation (SD) of histological traits the *m. pectoralis superficialis* of 24-week-old crossbred geese

Group		Muscle fibre diameters (μm)		Muscle fibre content (%)		Number of muscle fibres per area (0.545 mm^2)	Intramuscular fat content (%) per area (2.178 mm^2)
		αW	βR	αW	βR		
		♂♀	♂♀	♂♀	♂♀	♂♀	♂♀
I	$\bar{x}$	44.2	22.1	26.2	73.8	267	4.6
	SD	4.8	2.9	4.7	4.7	55.1	1.7
II	$\bar{x}$	44.1	21.4	25.3	74.7	316	3.9
	SD	6.1	4.2	3.6	3.6	69.5	1.2
III	$\bar{x}$	43	19.4	28.9	71.1	316	6.7
	SD	5.2	2	5.7	5.7	73	3.6
IV	$\bar{x}$	46	20.4	28.2	71.8	256	5.7
	SD	3.5	2.3	3.9	3.9	60.4	2.6

The results of histological analysis of ganders are in Table 3. The largest diameters of αW fibers (47.2 μm) and their percentage share (26.6%) and the lowest percentage share of βR fibers (73.4%) were found in goose from group I. The largest diameters of βR fibers (22.9 μm) and their percentage share (74.4%) and the smallest diameters of the αW fibers (45.1 μm) and their percentage share (25.6%) and the lowest content of intramuscular fatty tissue (4.21%) were found in the goose form group II. The largest number of fibers per unit area (315) and the content of intramuscular fatty tissue (7.96%) were found in geese from group III. The smallest diameters of βR fibers (19.6 μm) were found in group III and lowest number of fibers per area in group IV (271). Statistically significant differences between the experimental groups were found only for the intramuscular fatty tissue content ($P<0.05$).

Table 3. Mean values ($\bar{x}$) and standard deviation (SD) of histological traits the *m. pectoralis superficialis* of 24-week-old ganders (♂)

Group		Muscle fibre diameters (μm)		Muscle fibre content (%)		Number of muscle fibres per area (0.545 mm^2)	Intramuscular fat content (%) per area (2.178 mm^2)
		αW	βR	αW	βR		
I	$\bar{x}$	47.2	22.1	26.6	73.4	272	4.4^b
	SD	5	3.2	6.3	6.3	64.7	2.3
II	$\bar{x}$	45.1	22.9	25.6	74.4	278	4.2^b
	SD	7.1	5.6	2.9	2.9	60.3	1.5
III	$\bar{x}$	46.5	19.6	26.2	73.8	315	7.9^a
	SD	3.8	0.7	4.9	4.9	63.9	4.4
IV	$\bar{x}$	46.6	20.9	26.2	73.8	271	6.8^{ab}
	SD	3.2	1.9	3.9	3.9	59.3	2.7

^{a,b}Mean values fallowed letters differ significantly (P<0.05).

In the females (Table 4) largest diameters of both types of muscle fibers (αW – 49.1 μm, αR – 22.2 μm) were found geese from group I. The highest percentage share of βR fibers (75.1%), number of fibers per unit area (354) and lowest αW fibers content (24.9%) and intramuscular fatty tissue content (3.67%) were found in individuals from group II. The highest percentage share of βW fibers (31.5%) and intramuscular fatty tissue (5.39%) and the smallest diameters of both types of muscle fibers (αW – 39.5 μm, αR – 19.2 μm) and βR fibers percentage share (68.5%) noticed in birds from group III. Group IV characterized the lowest number of fibers per unit area (240). The statistically significant differences between the groups in the values of the analyzed traits were shown for: fibers diameters αW, the percentage share of both types of the muscle fibers and their number per unit area (P<0.05).

Table 4. Mean values ($\bar{x}$) and standard deviation (SD) of histological traits the *m. pectoralis superficialis* of 24-week-old geese (♀)

Group		Muscle fibre diameters (μm)		Muscle fibre content (%)		Number of muscle fibres per area (0.545 mm^2)	Intramuscular fat content (%) per area (2.178 mm^2)
		αW	βR	αW	βR		
I	$\bar{x}$	49.1^{a}	22.2	25.8^{ab}	74.2^{ab}	263^{b}	4.9
	SD	5	3	3.1	3.1	51.1	0.8
II	$\bar{x}$	43.1^{ab}	19.9	24.9^{b}	75.1^{a}	354^{a}	3.7
	SD	5.5	1.6	4.5	4.5	60.3	0.7
III	$\bar{x}$	39.5^{b}	19.2	31.5^{a}	68.5^{b}	317^{ab}	5.4
	SD	3.9	2.9	5.6	5.6	88.9	2.2
IV	$\bar{x}$	45.9^{a}	20	30.2^{ab}	69.8^{ab}	240^{b}	4.7
	SD	4.3	2.7	3.1	3.1	63.8	2.2

^{a,b}Mean values fallowed letters differ significantly (P<0.05).

Analysis of the results shows that compared to triple crossbreds, hybrids derived from replacement (quadruple) crossing are characterized by lower diameters and greater number of both muscle fibre types, as well as greater proportion of white fibres and intramuscular fat (Walasik and Bogucka, 2005). Also, differences in some muscle microstructure traits between quadruple and triple crosses do not reduce their value estimated at cellular level, because the results obtained are more favourable than those obtained for geese of meat lines (Kłosowska et al., 1993, 1998). Similarly, Gumułka et al. (2009) noticed that muscle fibers diameters are lower in the pectoral muscle and higher percentage share of red fibers (βR) in the geese from conservation flock. The structure of the geese breast muscle is similar to the structure of the quails pectoral muscles. In the pectoral muscle of the quails is also a greater number of red fibers (βR) and a low fat content, making them a high quality raw material (Młynek et al., 2016). The results of evaluation of microstructural traits of *m. pectoralis superficialis* are suggest of their high quality.

Conclusions

Based on the obtained results of evaluation of basic slaughter and histological traits of it can be stated that the greylag geese crosses with White Kołuda and Slovakian geese gives the possibility of using these birds in commercial breeding for production of high meat quality.

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