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DESCRIPTION OF SELECTED CHARACTERISTICS OF MUSCLE AND FAT TISSUE OF 10-WEEK WHITE KOLUDA W31® GEESE*

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Abstract. 60 White Koluda W31® geese (30 females and 30 males) constituted the experimental material. The birds were raised in the intensive system to 10 weeks of age in a closed space, under the conditions specified by the recommended technology. The birds were fed only concentrate mixtures *ad libitum*. In the 10th week the birds were individually weighed, which was the basis for selecting 5 males and 5 females for slaughter. The slaughter analysis and carcass division into individual tissue components were conducted. PH_1 of breast muscles as well as thigh and shank muscles, their chemical composition water binding capacity and thermal drip were determined. Moreover, the fatty acid profiles for the skin with subcutaneous fat and abdominal fat were studied. Breast muscles of 10--week 60 White Koluda W31® geese broilers contained 20.01% of crude protein and 2.76% of crude fat whereas the respective values for thigh and shank muscles were 18.50 and 4.73%. Additionally, the analysed muscles were characterized by beneficial values of processing characteristics. The fatty acid profile analysis for the skin with subcutaneous fat and abdominal fat showed that both tissues have got a relatively good profile of fatty acids. The analysis of the content of individual fatty acids of examined tissues showed that oleic acid was dominating (about 55-61) and it was followed by palmitic acid (about 22-23%) and linolic acid (about 8-10%). Monounsaturated fatty acids constituted 57.8--63.8% and polyunsaturated acids 8.50-12.15%. The SFA:PUFA ratio ranged from 2.34 in the thigh and shank muscles to 3.42 in subcutaneous fat. The results obtained show that both the meat and fat of geese broilers are characterized by a relatively good nutritive and processing value and can diversify the range of poultry products on the market.

Key words: geese broilers, muscle and fat tissue, chemical composition, fatty acids

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INTRODUCTION

Live poultry production in Poland was at the level of 1134-1400 th tonnes in the years 2002-2005 [Rynek drobiu i jaj 2005]. Slaughter geese constitute about 5% in this structure [Bąkowicz 2004]. Geese raising aiming at export is perceived as one of the specializations of Polish poultry production [Rosiński et al. 1999]. For many years Polish geese have had a high and stable position on the European market where they are known to be a brand product called "Polish oats goose".

Live geese are produced on the basis of the White Koluda W31® breed which originates from and is continually improved at the reproduction farm in Koluda Wielka (at present National Geese Research and Breeding Centre) owned by the Institute for Animal Husbandry. The birds are raised according to the technology prepared at the abovementioned farm, in the semi-intensive system up to 16-17 weeks of age. In their feeding many crushed cereal meals, green forage and oats grain are utilized in addition to concentrate feeds [Bieliński 1983].

The geese reared abroad, especially in Hungary, Czech Republic and Russia, are raised in the intensive system [Toth and Bodi 1990, Bąkowicz and Sobczak 2003]. In Poland, the production is not very popular although the first attempts were made as long ago as in the 1970s [Bielińska et al. 1980, Bieliński 1981]. The factor limiting this kind of production is, among other things, the notion that the meat of young geese is "immature" and not as tasty as the meat of 17 or 24-week-old geese. However, the recent research results point to the possibility of introducing in Poland at least preliminary geese production in the intensive system, that is the production of geese broilers slaughtered at about 9-10 weeks of age [Bąkowicz 2004, Biesiada-Drzazga 1998]. The literature on poultry includes a number of works describing processing values of poultry meat and its nutritive value [Bieliński et al. 1983, Biesiada-Drzazga and Górski 1998, Rosiński et al. 1999, 2000]. However, there are no works pertaining to the evaluation of slaughter material quality, including the quality of meat and fat produced by geese broilers, especially by W31 geese which are two-line crossbreds of the White Koluda breed. This gap was the stimulus to carry out the present study which aimed at determining the chemical composition and fatty acid profile for the skin with subcutaneous fat and abdominal fat of White Koluda W31® geese reared in the intensive system to 10 weeks of age.

MATERIALS AND METHODS

60 White Koluda W31® geese (30 females and 30 males) constituted the experimental material. The birds were raised to 10 weeks of age in a closed space, under the conditions specified by the recommended technology [Bieliński 1981]. The birds were fed concentrate mixtures *ad libitum*. The nutritive value of the mixtures applied in the successive rearing stages (0-3, 4-8 and 9-10 wk) are presented in Table 1. In the 10th week of rearing the birds were individually weighed, which was the basis for selecting 5 males and 5 females for slaughter ensuring that the groups were representative [Trętowski and Wójcik 1991]. After slaughter the pH of breast and shank muscles (pH_1) was measured within 15 minutes from the moment of cutting blood vessels. A slaughter analysis was carried out, then the carcasses were cooled and after 24 hours their division

Table 1. Chemical composition of mixtures, %
Tabela 1. Skład chemiczny mieszanek, %

Components Składniki	Feeding periods, weeks – Mixtures Okresy żywienia, tygodnie – Mieszanka		
	0-3 – M-1	4-8 – M-2	9-10 – M-3
Metabolizable energy, MJ Energia metaboliczna, MJ	11.97	12.13	11.75
Crude protein, % Białko ogólne, %	20.03	18.10	16.64
Crude fibre, % Włókno surowe, %	3.19	3.58	4.20
Ca, %	1.36	0.95	0.52
P, %	0.49	0.49	0.37

into individual tissue components was conducted [skin with subcutaneous fat, abdominal fat, breast muscles, thigh and shank muscles, bones – the so-called carcass remains] with simultaneous sampling for further analysis. Muscle chemical composition was determined by of the conventional Weende method of Henneberg – Stohmann [Skulmowski 1974] and the kinds of muscle tissue fatty acids as well as the skin with subcutaneous fat and abdominal fate were determined by means of the gas chromatography method using the "Chrom 5" apparatus. Moreover, there were determined the water binding capacity of breast muscles using the centrifuge method and the thermal drip of breast muscles and leg muscles [Mroczek 1997]. The data obtained were analysed by means of basic statistical methods [Trętowski and Wójcik 1991].

RESULTS AND DISCUSSION

Geese breast muscles were characterized by significantly higher crude protein content (20.01 and 18.51%, respectively) and significantly lower crude fat content (2.76 and 4.73%, respectively) compared with the thigh and shank muscles. The data obtained support the thesis of the authors who showed that chemical composition depends on the kind of muscle in geese [Batura et al. 1998]. In the authors' earlier studies [Biesiada-Drzazga and Górski 1998] 10-week W11 line geese broilers were characterized by markedly higher crude protein content and crude fat content in both breast muscles (21.61 and 5.21%, respectively) and leg muscles (19.50 and 6.69%, respectively) compared with the results of the present study. Moreover, the breast muscles of W11 geese raised in the semi-intensive system in the above-mentioned research contained 22.01% of crude protein and 6.46% of crude fat whereas the respective contents for thigh and shank muscles were 20.27 and 7.40%. In the studies by Rosiński et al. [1999] the crude protein contents in the breast muscles of 17-week White Koluda female geese of W11 and W33 lines as well as of W13 and W31 crossbreds were 22.0, 21.9, 22.8, and 22.8%, respectively, and for males the respective values were: 21.9, 22.3, 22.8 and 22.0%. The fat content in the muscles of females and males averaged: 6.3-6.5, 6.0-5.6, 5.0-5.5

and 4.5-5.9%, respectively. The results of Rosiński et al. [1990] obtained for W11 geese were similar to the results of the authors' earlier studies [Biesiada-Drzazga 1998]. To sum up, the comparison of crude protein and crude fat contents, being the most important components in the breast and leg muscles of geese broilers, with literature data pertaining to oats slaughter geese shows that geese broiler meat contains less crude protein but at the same time markedly less crude fat.

One of the methods for determining poultry meat quality is pH measurement which enables separating normal meat from imperfect meat of PSE or DFD type [Jakubowska et al. 1999]. In the present study the pH_1 value was 6.21 for breast muscles and 6.37 for leg muscles. For normal meat the value of pH = 5.9-6.2 whereas DFD (dark, firm, dry) meat has got the pH value ≤ 6.4 [Jakubowska et al. 1999]. It should be stressed that the meat with a low pH value is characterized by unfavourable water binding capacity, higher thermal drip and is less juicy [Grabowski 2002]. In the present study the water binding capacity and thermal drip of breast muscles were 44.60% and 29.73, respectively whereas the water binding capacity for thigh and shank muscles was 28.21%. The research by Rosiński et al. [1999] resulted in the following data for W31 geese raised in the semi-intensive system: the water binding capacity of breast muscles of males was 40.0% and for females only 15.6%, the thermal drip was 25.2 and 18.45, respectively.

Table 2. Chemical composition of muscles, %
Tabela 2. Skład chemiczny mięśni, %

Specification Wyszczególnienie	Chemical composition, % Skład chemiczny, %				pH_1	Water holding capacity WHC Wodochłonność %	Cooking losses SG Wyciek termiczny %
	dry matter sucha masa	crude protein białko ogólne	crude ash popiół	crude fat tłuszcz surowy			
Breast muscle Mięśnie piersiowe	24.82	20.01	0.93	2.76	6.21	44.60	29.73
Thigh and shank muscle Mięśnie ud i podudzi	25.01	18.50	0.88	4.73	6.37	–	28.21

The evaluation of the composition of fatty acids isolated form muscle tissue is a significant issue as lipids constitute a component of meat and co-influence its nutritive value [Batura et al. 1999]. The breast muscles contained more saturated and significantly less unsaturated fatty acids (Table 3) compared with the thigh and shank muscles. Among the saturated fatty acids, in both studied muscles palmitic acid ($C_{16:0}$) had the highest share and it was followed by stearic acid ($C_{18:0}$) whereas in the case of unsaturated acids the order was as follows: oleic acid ($C_{18:1}$), linolic acid ($C_{18:2}$) and then palmitoleic acid ($C_{16:1}$). In the work by Batura et al. [1999] on the breast muscles of 10-week WD1 geese palmitic acid constituted 25.3%, stearc acid 11.7% and oleic acid 46.2% of muscle fat.

Saturated fatty acids constituted 27.1% and unsaturated ones 72.8% of the total content of fatty acids in the skin with subcutaneous fat (Table 3). The respective values for abdominal fat were: 28.9 and 70.8%. Thus the skin with subcutaneous fat was characterized by a slightly more favourable ratio of fatty acids compared with the abdominal fat. Similar results were obtained by Karpińska and Batura [1998]. By contrast, Rosiński et al.

Table 3. Fatty acids content of the total of fatty acids in muscles, skin with subcutaneous fat and abdominal fat, %
Tabela 3. Zawartość poszczególnych kwasów tłuszczowych w mięśniach, skórze z tłuszczem podskórnym i tłuszczu sadełkowym, %

Specification Wyszczególnienie	Saturated fatty acids (SFA) Nasycone kwasy tłuszczowe						Unsaturated fatty acids (UFA) Nienasycone kwasy tłuszczowe											Other Pozostałe
	$C_{14:0}$	$C_{15:0}$	$C_{16:0}$	$C_{17:0}$	$C_{18:0}$	total łącznie	$C_{14:1}$	$C_{15:1}$	$C_{16:1}$	$C_{17:1}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	$C_{20:1}$	$C_{20:2}$	$C_{20:4}$	total łącznie	
Breast muscles Mięśnie piersiowe	0.18	0.03	22.29	0.13	7.27	29.90[a]	0.03	0.16	2.71	0.14	54.64	10.24	0.67	0.18	0.12	1.08	69.97[b]	0.13
Thigh and shank muscles Mięśnie ud i podudzi	0.15	0.01	21.49	0.02	6.10	27.77	0.02	0.11	2.96	0.22	56.78	10.31	0.60	0.18	0.05	0.91	72.14[a]	0.09
Skin with subcutaneous fat Skóra z tłuszczem podskórnym	0.13	–	22.07	–	4.91	27.11[b]	0.02	–	2.94	–	60.70	8.64	0.37	0.15	–	–	72.82[a]	0.07
Abdominal fat Tłuszcz sadełkowy	0.12	–	23.12	–	5.69	28.93	0.02	–	2.23	–	59.73	7.88	0.59	0.38	–	–	70.83	0.24

	SFA/PUFA	MUFA	PUFA
Breast muscles Mięśnie piersiowe	2.47	57.85	12.11
Thigh and shank muscles Mięśnie ud i podudzi	2.34	60.27	11.87
Skin with subcutaneous fat Skóra z tłuszczem podskórnym	3.01	63.81	9.01
Abdominal fat Tłuszcz sadełkowy	3.42	62.36	8.47

[a, b]Means followed by the same letter do not differ statistically at $P \leq 0.05$.
[a, b]Średnie oznaczone tymi samymi literami nie różnią się istotnie przy $P \leq 0,05$.

[1999] found that the abdominal fat of 17-week White Koluda W31® geese contained less unsaturated fatty acids, oleic acid in particular, compared with the abdominal fat in the present work.

The analysis of the fatty acid profile of examined tissues showed that the dominating fatty acid was oleic acid (about 55-61%) and it was followed by palmitic acid (about 22--23%) and linolic acid (about 8-10%). Monounsaturated fatty acids constituted 57.8--63.8% and polyunsaturated fatty acids 8.50-12.15%. The ratio of SFA and PUFA ranged from 2.34 in thigh and shank muscles to 3.42 in abdominal fat. According to the recommendations of World Health Organisation (WHO) specifying the nutritional consumption standards of daily amounts of individual kinds of fatty acids, the SFA:PUFA ratio should be 1:1 [Osek et al. 2002].

CONCLUSION

Breast muscles of 10-week 60 White Koluda W31® geese broilers contained 20.01% of crude protein and 2.76% of crude fat whereas the respective values for thigh and shank muscles were 18.50 and 4.73%. Additionally, the analysed muscles were characterized by beneficial values of processing characteristics. The fatty acid profile analysis for the skin with subcutaneous fat and abdominal fat showed that both tissues have got a relatively good profile of fatty acids. The analysis of the content of individual fatty acids of examined tissues showed that oleic acid was dominating (about 55-61) and it was followed by palmitic acid (about 22-23%) and linolic acid (about 8-10%). Monounsaturated fatty acids constituted 57.8-63.8% and polyunsaturated acids 8.50-12.15%. The SFA:PUFA ratio ranged from 2.34 in the thigh and shank muscles to 3.42 in subcutaneous fat. The results obtained show that both the meat and fat of geese broilers are characterized by relatively good nutritive and processing value and can diversify the range of poultry products on the market.

It can be concluded that the notion of meat quality is very difficult to define due to the fact that it is differently understood and evaluated by the producer, processing plant and the consumer. However, the results obtained show that the meat and fat of geese broilers are characterized by a relatively good nutritive and processing value and can diversify the range of poultry products on the market.

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CHARAKTERYSTYKA WYBRANYCH CECH TKANKI MIĘŚNIOWEJ I TŁUSZCZOWEJ 10-TYGODNIOWYCH GĘSI BIAŁYCH KOŁUDZKICH® W31

Streszczenie. Materiałem badawczym było 60 gęsi (30 samic i 30 samców) W31 rasy białej kołudzkiej®. Ptaki odchowywano systemem intensywnym do wieku 10 tygodni w zamkniętym pomieszczeniu, w warunkach zgodnych z zalecaną technologią. Ptaki żywiono *ad libitum* wyłącznie mieszankami treściwymi. W 10 tygodniu odchowu ptaki zważono indywidualnie i na tej podstawie wybrano do uboju pięć samców i pięć samic. Przeprowadzono analizę rzeźną ptaków oraz rozbiór tuszki na poszczególne składniki tkankowe. Określono pH_1 mięśni piersiowych oraz mięśni ud i podudzi, ustalono ich skład chemiczny, a także wodochłonność i wyciek termiczny. Ponadto ustalono profil kwasów tłuszczowych skóry z tłuszczem podskórnym oraz tłuszczu sadełkowego. Mięśnie piersiowe 10-tygodniowych brojlerów gęsich W31 rasy białej kołudzkiej zawierały 20,01% białka ogólnego i 2,76% tłuszczu surowego, natomiast mięśnie ud i podudzi odpowiednio 18,50 i 4,73%. Analizowane mięśnie charakteryzowała również dobra wartość cech technologicznych. Analiza profilu kwasów tłuszczowych skóry z tłuszczem podskórnym oraz tłuszczu sadełkowego wykazała, że obie te tkanki odznaczają się dość korzystnym profilem kwasów tłuszczowych. Z analizy profilu kwasów tłuszczowych badanych tkanek wynika, że dominujący był kwas oleinowy (ok. 55-61%), w następnej kolejności kwas palmitynowy (ok. 22-23%) oraz kwas linolowy (ok. 8-10%). Jednonienasycone kwasy tłuszczowe stanowiły 57,8-63,8%, a wielonienasycone 8,5-12,15. Stosunek SFA do PUFA wynosił od 2,34 w mięśniach ud i podudzi do 3,42 w tłuszczu sadełkowym. Uzyskane wyniki wskazują zatem, że mięso, a także tłuszcz gęsich brojlerów odznacza się stosunkowo dobrą wartością odżywczą i technologiczną oraz może wzbogacać asortyment produktów drobiowych na rynku.

Słowa kluczowe: brojlery gęsie, tkanka mięśniowa i tłuszczowa, skład chemiczny, kwasy tłuszczowe

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