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THE EFFECT OF ORIGIN, SEX AND FEEDING ON SENSORY EVALUATION AND SOME QUALITY CHARACTERISTICS OF GOOSE MEAT FROM POLISH NATIVE FLOCKS*

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Abstract

The aim of the study was to characterize the sensory quality and physical traits of raw and heat-treated meat depending on the origin, sex and feeding of geese. The experiment used meat from domestic geese of southern varieties: Lubelska (Lu), Kielecka (Ki) and Subcarpatian (Sb), included in the conservation programme. The experiment was carried out on a total of 192 birds divided according to origin (Lu, Ki and Sb), sex (M and F) and dietary treatment (DI – conventional feeding and DII – oat fattening). To evaluate the quality characteristics of meat, 16 birds from each group were selected. Sensory evaluation of raw goose muscles was at a good level of consumer acceptability and exceeded 4.0 points, ranging from 4.18 pts (appearance/Ki) to 4.59 pts (aroma/Sb) for breast muscles (BM), and from 4.17 pts (fatness/Lu) to 4.53 pts (aroma/Sb) for leg muscles (LM). In the case of heat-treated muscles the tenderness of the muscles of Lu geese was characterized by high number grade ($P \leq 0.05$) for both the BM (4.87 pts) and LM (4.76 pts). Lighter colour (L*) ($P \leq 0.05$) was characteristic of the muscles of oat-fattened birds (44.25 for BM and 49.86 for LM) compared to the muscles of conventionally fed birds (39.77 for BM and 46.89 for LM). In addition, a significant ($P \leq 0.05$) effect of diet was also found on the value of the parameter a* (redness) and b* (yellowness). Parameter a* ranged from 10.45 (Lu) to 11.96 (Ki) for BM and from 13.28 (Ki) to 14.21 (Sb) for LM. In turn, the highest share ($P \leq 0.05$) of yellow colour (parameter b*) was demonstrated in the muscles of Ki geese – 4.87 for BM and 10.92 for LM. Male muscles were characterized by higher (26.34 mg% – BM and 24.37 mg% – LM) water holding capacity (WHC) than female muscles (27.23 mg% for BM and 25.28 mg% for LM respectively). Furthermore for BM of oat-fattened geese cooking loss was at the level of 10.50%. The present study indicated that most of the sensory characteristics of meat (BM and LM) from geese of different breeds were affected (significantly at $P \leq 0.05$) by the diet. This concerned both raw and heat-treated meat. For raw breast muscles, a significant ($P \leq 0.05$) effect of sex was also found (with the exception of aroma). In turn, the quality characteristics of raw leg muscles (except for colour) were influenced ($P \leq 0.05$) by all the treatment factors. Analysis of the physical properties of meat showed that these parameters are mainly affected ($P \leq 0.05$) by the diet.

Key words: goose, genotype, diet, meat, sensory analysis, physical properties

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The production of goose meat in Poland is carried out mainly (95%) using W-31 hybrids originating from the ♂ W-33×♀ W-11 breeding line, i.e. based on White Kołuda goose® (Wencek et al., 2015). However, it is worth drawing attention to older breeds of geese kept in the territory of Poland. Today this population is small with around 5,000 geese representing 14 breeds/strains/lines. However, they may constitute a very good source of niche production of goose meat for regional and organic products (Krawczyk and Bielińska, 2007; Książkiewicz, 2010; Krawczyk et al., 2014). Native varieties of geese are well adapted to the local environment. This type of poultry is easy to rear, hardy, and less susceptible to many common diseases. What is more, these birds are characterized by a well-proportioned body, very good muscling and low carcass fatness, while showing very good conversion of food (Mazanowski et al., 2006; Książkiewicz, 2010; Gornowicz et al., 2012). Also in other countries, researchers increasingly often focus on meat from the native breeds intended for extensive husbandry (Romanow, 1999; Isguzar and Pingel, 2003; Hamadani et al., 2013; Uhlířová and Tůmová, 2014).

Meat quality is a complex concept that should be considered from many aspects, including its nutritive value, technological value, and sensory characteristics. It is affected to varying degrees by many factors such as genotype, age, diet, rearing system, and also sex (Mazanowski et al., 2004; Szwaczkowski et al., 2007; Gumułka et al., 2009; Liu et al., 2011; Kirmizibayrak et al., 2011; Okruszek, 2012; Haraf, 2014). In turn, Bourne (2002) considers appearance, aroma, texture and nutritive value as the principal quality factors in foods. The first three are known as sensory acceptability factors, because unlike nutritive value they are mostly perceived by our senses.

The sensory acceptability of food products is crucial, because humans derive great satisfaction from eating the foods they like (Bourne, 2002; Surmacka-Szcześniak, 2002; Połom and Baryłko-Pikielna, 2004). The quality of poultry meat is perceived in terms of its sensory and health characteristics as well as processing convenience. Central to the consumer meat selection process is the total score, which includes visual assessment (colour, fatness) and the subsequent sensory assessment, viewed as a combination of traits such as palatability, tenderness and juiciness. These traits are important determinants of meat quality for the modern buyer, whose consumer behaviour has a direct effect on profitability of the meat production sector (Nowak and Trziszka, 2010).

The aim of the study was to characterize the sensory quality and physical traits of raw and heat-processed meat depending on the origin, sex and diet of geese from Polish native flocks.

Material and methods

Experimental material and rearing

The experiment was approved by the 2nd Local Ethics Committee at the Institute of Pharmacology of the Polish Academy of Sciences in Kraków.

The experiment used meat from domestic geese of southern varieties: Lubelska (Lu), Kielecka (Ki) and Subcarpathian (Sb). These flocks are included in the conservation programme and are kept *in situ* at the Waterfowl Genetic Resources Station in Dworzyska, which belongs to the Experimental Station of the National Research Institute of Animal Production in Kołuda Wielka.

The experiment was carried out on a total of 192 birds divided according to dietary treatment (DI – rearing geese without fattening and D II – rearing geese with oat fattening), origin (Lu, Ki and Sb) and sex (M and F). To evaluate the quality characteristics of meat, 16 birds from each group were selected based on mean body weight (oat fattening – 4.56 kg; fattening without oats – 4.16 kg).

Birds were reared for 20 weeks in a free-range system. During the rearing period up to 3rd week of age, they were kept on straw in a windowless confinement facility. From 4rd to 5th weeks of age, birds were housed with outdoor access, and from 6th week they were confined to a sand yard. Nutritional value of feed mixtures in particular periods of life of birds were shown in Table 1.

Table 1. Nutritional value of feed mixtures

Item	Rearing period		
	0–3 weeks	4–8 weeks	9–16 weeks
ME (MJ/kg)	11.72	11.50	11.00
Crude protein (%)	20.00	18.50	14.50
Ca (%)	1.03	1.50	0.64
Available P (%)	0.43	1.00	0.32

Two feeding groups were formed after 16 weeks. One group was fed the diet from the last period of life (9–16 week) and forage *ad libitum* until the end of the study (D I), and another group, following a week-long adaptation period, received only whole oat grain over the last 21 days of rearing (oat fattening – D II). After 12 h of feed (but not water) withdrawal, birds were subjected to slaughter and post-slaughter processing in the Waterfowl Genetic Resources Station in Dworzyska. All the procedures conformed to this type of technological process. Subsequently the carcasses were chilled in water with ice to an internal temperature of 9°C (breast muscle) and then placed in refrigerators (4°C).

After 24 hours chilled carcasses were dissected (Ziołecki and Doruchowski, 1989). Both breast muscles (BM, *m. pectoralis superficialis* and *m. pectoralis profundus*) and leg muscles (LM – thigh and drumstick together) were collected for analysis of quality traits. Muscles for raw meat analysis were collected from the right side of carcass, and muscles for heat treatment were taken from the left side.

Sensory evaluation

Sensory evaluation of raw meat (BM and LM) was performed 24 h post-mortem using the parts chilled to an internal temperature of 4°C. The test was performed by a regular panel of 5 experts in accordance with the method described by Ziołecki (1988) and Baryłko-Pikielna and Matuszewska (2009), modified according to relevant standards (PN-ISO-11036:1999; PN-ISO-5496:1997; PN-ISO-3972:1998; PN-ISO-13299:2003). A 4-point hedonic scale from 2 (lowest quality) to 5 (highest quality) was used. Each quality characteristic was scored to the nearest 0.5. The final score was the arithmetic mean of the individual scores, calculated to the nearest 0.1 point. Forty-eight hours post-mortem, sensory characteristics of the goose meat (BM and LM) were analysed after it was cooked covered in water (sample to water ratio of 1:2) with table salt (1% of all) for 6 minutes per 100 g of the sample, counting from boiling point (Ziołecki, 1988). During the sensory evaluation, the quality of raw meat was rated by the appearance, colour, aroma and fatness whereas the quality of heat-treated meat by flavour, aroma, tenderness, and juiciness. The values of these parameters were used to calculate the total score for the analysed sensory traits of goose meat.

Technological properties

Twenty-four hours post-mortem, water holding capacity (WHC) was determined, according to the method reported by Grau and Hamm (Grau and Hamm, 1952) in the modification proposed by Pohja and Ninivaara (Pohja and Ninivaara, 1957) and cooking loss (CL) according to the method described by Pikul (1993). Meat colour was determined with CIE 1976 L*a*b* system (CIE, 2007) using a Minolta CM-508 spectrophotometer (D_{65} illuminant, 10° observer, 8-mm aperture, calibrated with a white plate: L* – 99.18, standard white – standard number 14971035). These parameters were determined on the surface of the muscle from the bone dissected direction, at three measurement sites and in three replications. The determination result was the mean value of the measurements made in different muscle groups (BM and LM).

Statistical analysis

Statistica 10.0 package system was used to calculate the means ($\bar{x}$) and standard deviations (SD). Significant differences were specified by Duncan's multiple range test. Differences were considered as significant at the level of $P \leq 0.05$. Three-way analysis of variance was performed and significant effect of each factor was evaluated with Snedecor's F-test.

$$Y_{ijk} = \mu + a_i + b_j + c_k + (abc)_{ijk} + e_{ijk}$$

where:

Y_{ijk} – value of traits,
a_i – the effects of the 1st experimental factor (origin),
b_j – the effects of the 2nd experimental factor (sex),
c_k – the effects of the 3rd experimental factor (feeding),
$(abc)_{ijk}$ – the interaction effect of experimental factors,
e_{ijkk} – residual error.

Table 2. Sensory quality of raw goose meat depending on origin, sex and diet

Parameter		O			S		D		Effect of factors (F-test)			Interactions (F-test)			
		Lu	Ki	Sb	♂	♀	I	II	O	S	D	O×S	O×D	S×D	O×S×D
Breast muscles															
n		64	64	64	96	96	96	96							
appearance	$\overline{x}$	4.34	4.18	4.32	4.41 a	4.15 b	4.27	4.30	1.39	9.50*	0.14	9.64*	0.02	1.77	0.27
	SD	0.37	0.38	0.41	0.29	0.46	0.21	0.50							
colour	$\overline{x}$	4.50 b	4.51 bc	4.55 ac	4.55 a	4.48 b	4.42 b	4.63 a	2.32	13.37*	115.01*	8.73*	0.77	0.95	1.13
	SD	0.07	0.11	0.07	0.09	0.09	0.09	0.09							
aroma	$\overline{x}$	4.54 b	4.47 c	4.59 a	4.53	4.53	4.45 b	4.62 a	15.42*	0.07	86.40*	2.22	4.85*	24.07*	2.92
	SD	0.08	0.09	0.08	0.09	0.07	0.10	0.07							
fatness	$\overline{x}$	4.42	4.42	4.41	4.49 a	4.35 b	4.24 b	4.61 a	0.13	41.63*	270.37*	1.60	9.92*	0.39	8.19*
	SD	0.10	0.10	0.10	0.11	0.10	0.11	0.09							
total score	$\overline{x}$	4.45 bc	4.40 b	4.47 ac	4.50 a	4.38 b	4.34 b	4.54 a	2.96	22.09*	58.97*	11.77*	0.18	5.18*	0.22
	SD	0.11	0.12	0.11	0.10	0.13	0.08	0.15							
Leg muscles															
appearance	$\overline{x}$	4.19	4.29	4.30	4.39 a	4.13 b	4.16 b	4.36 a	3.74*	52.40*	31.06*	18.83*	1.38	0.69	6.22*
	SD	0.16	0.18	0.17	0.20	0.13	0.14	0.20							
colour	$\overline{x}$	4.23	4.25	4.28	4.41 a	4.10 b	4.17 b	4.34 a	0.76	67.56*	22.15*	3.12*	0.22	0.48	1.56
	SD	0.20	0.17	0.14	0.17	0.18	0.15	0.20							
aroma	$\overline{x}$	4.41 b	4.45 b	4.53 a	4.50 a	4.42 b	4.41 b	4.51 a	11.57*	14.94*	20.50*	3.01	3.16	8.89*	0.70
	SD	0.10	0.11	0.08	0.09	0.11	0.08	0.11							
fatness	$\overline{x}$	4.17 b	4.34 a	4.20 b	4.38 a	4.10 b	4.09 b	4.38 a	9.89*	73.41*	78.47*	11.03*	4,83*	0.19	3.99*
	SD	0.12	0.16	0.16	0.16	0.14	0.13	0.17							
total score	$\overline{x}$	4.25 b	4.34 a	4.33 a	4.43 a	4.19 b	4.21 b	4.40 a	5.27*	99.08*	65.17*	13.93*	0.17	1.93	3.35*
	SD	0.10	0.12	0.10	0.12	0.09	0.06	0.14							

Notes: O – origin; S – sex; D – diet; I – rearing geese without fattening, II – rearing geese with oat fattening; $\overline{x}$ – average value, SD – standard deviation; a, b – different letters in rows indicate the statistical significance of differences $P<0.05$; rating on a scale of 2.0 to 5.0 points; 2.0 is an insufficient level of quality, and 5.0 a good (desired) level of quality; F – value of the F-Snedecor test; * – the significance of F-test.

Table 3. Sensory quality of heat-treated goose meat depending on origin, sex and diet

Parameter		O			S		D		Effect of factors (F-test)			Interactions (F-test)			
		Lu	Ki	Sb	♂	♀	I	II	O	S	D	O×S	O×D	S×D	O×S×D
Breast muscles															
n		64	64	64	96	96	96	96							
flavour	$\bar{x}$	4.83	4.83	4.82	4.81	4.84	4.80 b	4.85 a	0.19	1.48	8.51*	0.99	0.04	0.24	0.01
	SD	0.08	0.11	0.08	0.09	0.08	0.10	0.08							
aroma	$\bar{x}$	4.78 a	4.71 b	4.75 bc	4.73	4.76	4.71 b	4.78 a	4.21*	1.40	12.64*	0.36	0.36	0.16	0.67
	SD	0.07	0.08	0.09	0.08	0.08	0.08	0.08							
tenderness	$\bar{x}$	4.87 a	4.83 b	4.81 b	4.83	4.85	4.81 b	4.87 a	4.85*	1.56	10.17*	0.92	0.54	0.48	0.08
	SD	0.07	0.07	0.09	0.08	0.08	0.07	0.08							
juiciness		4.83	4.81	4.79	4.79 b	4.83 a	4.78 b	4.84 a	1.78	6.52*	7.89*	0.11	0.51	0.26	0.02
	SD	0.08	0.08	0.09	0.08	0.09	0.07	0.09							
total score	$\bar{x}$	4.83 a	4.80 b	4.79 b	4.79 b	4.82 a	4.78 b	4.84 a	4.08*	5.48*	23.23*	0.06	0.21	0.61	0.19
	SD	0.05	0.06	0.05	0.05	0.05	0.06	0.05							
Leg muscles															
flavour	$\bar{x}$	4.73	4.72	4.73	4.74	4.71	4.68 b	4.77 a	0.02	1.91	24.02*	2.19	0.43	0.77	0.20
	SD	0.09	0.08	0.09	0.08	0.09	0.09	0.08							
aroma	$\bar{x}$	4.71 a	4.63 c	4.67 b	4.68	4.67	4.63 b	4.71 a	10.30*	0.25	34.67*	0.34	0.45	0.03	0.45
	SD	0.07	0.06	0.06	0.07	0.06	0.06	0.07							
tenderness	$\bar{x}$	4.76 ac	4.74 bc	4.71 b	4.74	4.74	4.71 b	4.77 a	2.90	0.02	12.34*	1.20	0.73	0.97	0.61
	SD	0.08	0.06	0.09	0.08	0.07	0.07	0.08							
juiciness	$\bar{x}$	4.75	4.75	4.73	4.72 b	4.77 a	4.71 b	4.78 a	0.64	7.98*	12.92*	0.81	0.31	0.07	0.61
	SD	0.08	0.08	0.10	0.07	0.10	0.08	0.09							
total score	$\bar{x}$	4.74 a	4.71 b	4.71 b	4.72	4.72	4.68 b	4.76 a	2.73	0.20	51.13*	0.89	0.33	0.90	0.17
	SD	0.05	0.04	0.05	0.05	0.05	0.06	0.04							

For notes, see Table 2.

Table 4. Mean values of physical traits of goose meat depending on origin, sex and diet

Parameter		O			S		D		Effect of factors (F-test)			Interactions (F-test)			
		Lu	Ki	Sb	♂	♀	I	II	O	S	D	O×S	O×D	S×D	O×S×D
Breast muscles															
n		64	64	64	96	96	96	96							
L*	$\bar{x}$	42.06	42.09	41.89	42.21	41.81	39.77 b	44.25 a	0.03	0.29	35.04*	1.88	0.69	0.74	0.07
	SD	3.51	3.63	3.25	3.41	3.52	3.93	2.93							
a*	$\bar{x}$	10.45	11.96	11.59	11.68	10.98	13.12 a	9.54 b	2.05	1.21	31.92*	0.66	0.23	0.19	0.15
	SD	2.53	3.64	2.36	2.86	2.94	3.28	2.46							
b*	$\bar{x}$	3.27 b	4.87 a	4.78 a	4.43	4.19	6.00 a	2.61 b	5.27*	0.28	56.10*	0.66	0.94	0.09	0.81
	SD	2.13	2.39	1.63	2.25	1.88	1.98	2.17							
WHC (mg%)	$\bar{x}$	26.82	26.55	26.99	26.34	27.23	27.59 a	25.98 b	0.16	1.95	6.34*	1.71	0.01	0.33	0.14
	SD	2.84	3.23	2.68	2.79	3.06	2.82	3.04							
CL (%)	$\bar{x}$	11.79	11.03	11.41	11.59	11.24	12.33 a	10.50 b	1.23	0.75	20.82*	1.00	0.06	0.01	1.11
	SD	2.46	1.55	1.28	1.73	1.93	2.39	0.99							
Leg muscles															
L*	$\bar{x}$	47.81 b	49.36 a	47.94 b	47.92 b	48.82 a	46.89 b	49.86 a	4.71*	3.90*	42.32*	1.69	1.53	0.32	2.33
	SD	2.58	2.20	1.28	2.21	1.97	2.20	1.98							
a*	$\bar{x}$	14.01 ab	13.28 b	14.21 a	13.72	13.95	15.37 a	12.30 b	2.67	0.45	78.98*	1.91	0.26	0.30	2.43
	SD	1.21	1.23	2.13	1.10	1.95	2.02	0.96							
b*	$\bar{x}$	10.47	10.92	10.85	10.45 b	11.04 a	12.03 a	9.45 b	0.78	3.47*	66.10*	2.94	3.55*	2.82	1.50
	SD	1.76	0.89	1.56	1.27	1.62	1.65	1.22							
WHC (mg%)	$\bar{x}$	24.43	24.88	25.16	24.37	25.28	24.58	25.07	0.41	1.89	0.54	0.33	0.15	1.71	1.57
	SD	3.64	3.40	1.59	2.86	3.18	2.32	3.59							
CL (%)	$\bar{x}$	9.61	9.37	10.10	10.09	9.30	8.95	10.44	0.88	2.89	10.52*	0.63	0.49	0.63	1.94
	SD	2.56	1.48	2.15	1.94	2.27	2.62	1.43							

Notes: L* – lightness, a* – redness, b* – yellowness, WHC – water holding capacity, CL – cooking loss; see Table 2.

Results

With regard to the origin (O) of geese, significant differences (P≤0.05) were observed in sensory quality of breast muscles (BM) for the colour (Lu and Sb), total score (Ki and Sb) and aroma (between all the evaluated populations) (Table 2). In the case of leg muscles (LM), there were significant (P≤0.05) differences between Sb vs Ki (0.08 pts) and Lu (0.12 pts) geese in aroma, between Ki vs Lu (0.17 pts) and Sb (0.14 pts) in fatness, and between Lu vs Ki (0.09 pts) and Sb (0.08 pts) in total score. Analysis of the effect of sex (S) revealed statistically significant (P≤0.05) higher note for the total score of males, by an average of 0.12 pts (BM) and 0.24 pts (LM). Considering the feeding system (D), muscles from oat-fattened geese had more favourable (P≤0.05) results compared to muscles from geese subjected to fattening. These scores ranged from 4.30 pts (appearance) to 4.63 pts (colour) for breast muscles, and from 4.34 pts (colour) to 4.51 pts (aroma) for leg muscles. The origin (O), sex (S) and diet (D) had a significant effect (P≤0.05) on the sensory traits of raw meat: LM (except for O×colour) and BM (except for origin: ×appearance, ×colour, ×fatness, ×total score and sex×aroma and also diet×appearance). For these sensory traits of meat, the largest number of statistically significant (P≤0.05) interactions was found between origin and sex (O×S).

Sensory analysis of heat-treated goose meat showed significant differences (P≤0.05) for three parameters (aroma, tenderness, total score) evaluated in terms of bird origin (O) (Table 3). Female BM were characterized by significantly (P≤0.05) more favourable note for the total score, by an average of 0.03 pts, compared to male BM (4.79 pts). In turn for LM they have reached the same level (non-significantly) of 4.72 pts for both sexes. As in the case of raw muscles, both the BM and LM from oat-fattened geese were characterized by more favourable (P≤0.05) notes than muscles from geese without fattening.

Three-way analysis of variance showed a significant (P≤0.05) effect of diet on all the sensory characteristics of heat-treated goose muscles. In addition, aroma, tenderness and total score for BM as well as aroma of LM were dependent on goose origin (O). Sex of birds had an effect only on juiciness of meat (BM and LM). No effect of interaction was found between origin (O), sex (S) and diet (D) of geese on the sensory characteristic of meat after heat treatment.

Photometric lightness, statistically significant (P≤0.05) was characteristic of the muscles of oat-fattened birds and the L* parameter was 44.25 for BM and 49.86 for LM (Table 4). Statistically significant (P≤0.05) differences were observed only for lightness of leg muscles in Ki vs Lu and Sb geese. Moreover it was found that the share of red colour (a* parameter) in the muscles colour ranged from 10.45 (Lu) to 11.96 (Ki) for BM and from 13.28 (Ki) to 14.21 (Sb) for LM (statistically significant P≤0.05). The highest share of yellow colour (b* parameter) was demonstrated in the muscles of Ki geese – 4.87 for BM and 10.92 for LM. The meat of the domestic geese of southern varieties was characterized by similar WHC, ranging from 26.55 (Ki) to 26.99 mg% (Sb) for BM, and from 24.43 (Lu) to 25.16 mg% (Sb) for LM. Higher WHC value was observed for males than females, by an average of 0.89 pp (BM) and 0.91 pp (LM), and for breast muscles of oat-fattened birds (by 1.61 pp on average) where statistically significant differences (P≤0.05) were shown. In addition, these differences were also observed for the cooking loss of goose breast muscles. The analysis of variance demonstrated a significant effect of diet on some physical properties of raw goose meat. The colour lightness and yellowness of leg muscles was also significantly influenced by sex of birds (F=3.90* and F=3.47*, respectively) and origin (F=4.71*/L*). There was no interaction between the analysed factors and the physical properties of meat (except for parameter b* of LM – interaction O×D).

Discussion

Geldenhuys et al. (2014) specified the sensory profile of heat-treated breast muscles from Egyptian geese. The aroma and flavour profile of the meat evaluated on a scale of 0 to 100 points was very distinct: aroma (41.9 pts), flavour (48.4 pts) and metallic flavour (28.2 pts). In our study we used a smaller 5 point scale and for the breast muscles of domestic southern varieties these parameters exceeded 4.63 pts, which is indicative of high consumer desirability of the product. The above mentioned authors also showed that the low juiciness and tenderness of BM in Egyptian goose was associated with high CL (29.99%). This observation agrees with the results of our study, in which low CL (from 8.95% LM/DI to 12.33% BM/DI), meat juiciness and tenderness (BM and LM) received very high scores in excess of 4.71 points. Furthermore, these parameters were found to be influenced mostly by diet, but also by sex (juiciness of BM and LM) and origin of birds (tenderness of BM).

Akinwumi et al. (2013) gave high notes (on a scale of 1 to 9) for colour (7.2 pts) and lower notes for aroma (5.0 pts) in the case of heat-treated goose muscles. Juiciness and tenderness of the studied muscles received low scores (less than 4.0 pts) with very high CL value of 39.8% for breast and 42.5% for leg muscles respectively. In our study, colour was evaluated as an indicator of raw meat sensory characteristic, which exceeded 4.41 pts for BM and 4.09 pts for LM. This trait was influenced by goose diet and sex as well as the interaction origin× sex (O×S).

The instrumental measurement of lightness in breast muscle of Egyptian geese (Geldenhuys et al., 2014) showed that these birds have a darker colour (L* – 40.92) of this group of muscles compared to other poultry species. The physical properties of muscles from Zatorska geese and commercial hybrids of W-31 White Kołuda® geese were evaluated by Gumułka et al. (2009). The lightness (L*) ranged from 38.52 (BM/Zatorska geese) to 40.54 (LM/W-31). The value of parameter a* ranged from 16.33 (LM/Zatorska geese) to 17.00 (BM /Zatorska geese) and for parameter b* from 3.46 (White Kołuda® geese/BM) to 4.38 (White Kołuda® geese/LM). In the study by Kirmizibayrak et al. (2011), the lightness of BM and LM for native geese from the Kars province (Turkey) ranged from 40.15 (♂) to 40.59 (♀) for BM and from 43.86 (♀) to 44.20 (♂) for LM, respectively. There has been shown a greater share of red and yellow colour in males: 13.61/BM and 10.38/LM as well as 1.16/BM and 1.15/LM, respectively. These authors did not find any effect of bird age and sex on lightness for both BM and LM as well as of sex on value of the parameters a* and b* (except a* parameter for BM). In our study origin and sex of the geese had no effect on BM lightness, but the effect of diet (P≤0.05) has been confirmed. The lightness of LM was affected by origin, sex and diet of geese.

Okruszek et al. (2008) analysed colour components (L*, a*, b*) of breast muscles of 17-week-old geese from conservative flocks 24 h after slaughter. The authors have demonstrated that the breast muscles of Subcarpathian geese were characterized by lighter colour (L* = 38.67), a greater share of redness (a* = 18.67) and a smaller share of yellowness (b* = 3.80) compared to our results, where values of L* and a* parameters of BM from Sb geese were higher (on average by 3.22 and 0.98, respectively) and value of b* parameter lower by 7.08. The red colour intensity (a*) of BM in our study was lower in comparison to the data presented by Okruszek et al. (2008) (on average by 6.49/Ki and 7.08/Sb, respectively) and Gumułka et al. (2009) (on average by 5.53 for BM and 2.51 for LM). However Kirmizibayrak et al. (2011) proved higher value of a* parameter for breast and leg muscles (13.61 and 10.30, respectively) from male of analysed goose. This is confirmed by our study in the case of BM but in the case of LM a higher value for this parameter was characteristic of the muscles of females (13.95). Besides, the authors found that the yellow colour intensity was greater in muscles of males than females (BM/1.16 and LM/1.15). In our study greater value of this parameter for males has been shown for BM (4.43). Okruszek et al. (2008) proved a slight share of yellow colour in BM of Ki geese (1.16) and Sb geese (0.79). In our research the value of this parameter was higher, on average 3.71 and 3.99 respectively.

Gumułka et al. (2009) reported that cooking loss was higher, by an average of 5.34 pp, for breast muscle compared to leg muscle from Zatorska geese. A similar relationship was observed in our study, but the difference was just 1.72 pp. The muscle of Zatorska geese was characterized by higher water holding capacity (on average by 7.81 pp for BM and by 6.33 pp for LM respectively) compared to Kielecka, Lubelska and Subcarpathian geese.

Kirmizibayrak et al. (2011) showed that water holding capacity of the analysed goose muscles did not exceed 10.0%, cooking loss of breast muscle did not exceed 30%, and age and sex of geese had no effect on these technological properties of meat. In our study, water holding capacity was expressly higher, by an average of 16.65 pp (♂) and 18.24 pp (♀) for breast muscle and by an average of 17.47 pp (♂) and 19.31 pp (♀) for leg muscle. Cooking loss was smaller, by an average of 15.08 pp (BM) and 18.13 pp (LM). Only the diet was found to have an effect on WHC and CL in BM and on CL in LM.

Conclusions

Our study showed that most of meat quality characteristics of geese from different breeds were significantly (P≤0.05) influenced by the diet. This concerned both raw and heat-treated meat (BM and LM).

The quality traits of raw breast muscles depended significantly (P≤0.05) also on the sex of birds (except for aroma) and those of leg muscles (except for origin×colour) were influenced by all the experimental factors.

Some of the analysed sensory parameters of heat-treated goose meat depended on the origin (aroma, tenderness, total score – breast muscle; aroma – leg muscle) and sex (juiciness, total score – breast muscle; juiciness – leg muscle).

Analysis of the physical properties of meat showed that these parameters are not dependent on the origin and sex of birds (except for L* of leg muscles) but are instead affected (P≤0.05) by the diet (except for WHC of leg muscles). The three populations of geese (Lu, Ki and Sb) are characterized by very good culinary properties expressed by the desirable level of selected meat quality characteristics. Their value can be modified first of all through proper feeding of geese. The meat of oat-fattened geese had a very good assessment of the sensory quality.

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