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Carcass Composition and Breast Muscle Microstructure in Guinea Fowl (*Numida meleagris* L.) of Different Origin

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Evaluation of dressing percentage and postmortem traits in 14-week-old white and grey guinea fowl, extended with evaluation of breast muscle microstructure, was the aim of the study. Subjects were two varieties of guinea fowl kept in an environmentally controlled house. Birds received complete commercial feeds. At 14 weeks of rearing, their whole carcasses were dissected postmortem. Diameters and percentages of white (αW) and red muscle fibres (βR) were determined based on histological analysis of the *musculus pectoralis superficialis*. Similar dressing percentage was found in both guinea fowl varieties. At 14 weeks of age, grey guinea fowl had greater body weight, and weight and proportion of leg muscles and wings compared to white guinea fowl. Females of the white variety had greater weight of breast muscles than males. Breast muscle microstructure showed significantly ($P \leq 0.05$) greater content and diameter of white fibres in grey guinea fowl, and of red fibres in white guinea fowl.

Key words: Guinea fowl, carcass composition, dressing percentage, muscle fibres.

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In Poland, guinea fowl are an undervalued and somewhat forgotten species of gallinaceous poultry, kept mainly in backyard systems.

Because there are no organized breeding and reproduction programmes for guinea fowl in Poland, and the number of studies on their farming under Polish conditions is small, a study was performed to evaluate the postmortem traits and breast muscle microstructure of white and grey guinea fowl aged 14 weeks.

When comparing the native variety with two types of guinea fowl broilers, SANTIAGO *et al.* (2007) revealed a significant effect of genotype on increased weight of breast muscles, their tenderness, and the weight of thigh muscles. The authors found that selection for high rate of growth significantly improves the meat traits of guinea fowl.

BAÉZA *et al.* (2001) compared different guinea fowl varieties and concluded that carcass weight is considerably affected by genotype, sex and rearing conditions. The carcass percentage of breast muscles is significantly influenced by genotype, and the content of depot fat and skin with subcutaneous fat is significantly affected by sex.

The quality of guinea fowl meat is often compared to chicken meat, but consumers appreciate its special qualities that resemble the meat of "wild" birds in taste (MEAD 2004).

The meat of wild fowl contains more red fibres, which has a positive effect on the properties of this meat (DRANSFIELD & SOŚNICKI 1999). As a result of long-term selection for improved meat performance, the breast muscles of broiler chickens contain 91-100% white fibres and 0-9% red fibres (ELMINOWSKA-WENDA 2007).

Observations at the cellular level provide information on the breast muscle microstructure. These data may serve as an indicator of meat quality. The percentage of white and red muscle fibres and their diameters largely affect the weight of muscles, as well as the tenderness and juiciness of meat (WALASIK & BOGUCKA 2005). Muscle weight depends on the total number of muscle fibres, their diameter, and the proportion of individual fibre types (ELMINOWSKA-WENDA 2007).

The profile of muscle fibre types is genetically determined. Changes in the distribution of muscle fibre types may depend on age, nutrition and physical activity (KŁOSOWSKA *et al.* 1998).

White Italian geese selected for meat production have more white fibres in breast muscle compared to those selected for egg production (KŁOSOWSKA *et al.* 1993). Chickens with a rapid growth rate are characterized by greater fibre diameters than those from slow-growing lines. The muscles of intensively farmed ducks contain more white fibres, and those of extensively farmed ducks have more red fibres (DRANSFIELD & SOŚNICKI 1999).

The evaluation and comparison of meat traits in guinea fowl may arouse the interest of potential producers of this avian species. Guinea fowl meat has the advantage of unique taste, which also in Poland could be an attractive proposition for consumers who look for healthy and tasty products.

The aim of the study was to compare white and grey guinea fowl for body weight, carcass weight, dressing percentage, carcass composition, and microstructure of the *musculus pectoralis superficialis*.

Material and Methods

The study was carried out according to the guidelines of the Ethical Committee in Bydgoszcz (No. 8/2004).

The study was carried out at the experimental poultry farm in Wierzchucinek, operating as part of the Agricultural Experimental Station Minikowo, which belongs to the University of Technology and Life Sciences in Bydgoszcz. White and grey guinea fowl and their meat served as experimental material. 34 birds of each variety were reared to 14 weeks of age. Guinea fowl were kept in an environmentally controlled house and received complete diets. Birds were fed a diet containing 19.5% crude protein and 12.4 MJ (2950 kcal) ME to 8 weeks of age, and a diet containing 17.5% protein and 12.6 MJ (3000 kcal) ME from 9 to 14 weeks of age.

At the end of 14 weeks of rearing, guinea fowl were slaughtered and their whole carcasses were dissected using the method described by ZIOŁECKI and DORUCHOWSKI (1989). Ten male and 10 female white and grey guinea fowl with close to average body weight for a given variety were selected for slaughter. After plucking, evisceration and 24-hour chilling, their carcasses were dissected into neck without skin, breast muscles, leg muscles, skin with subcutaneous fat from the whole carcass, abdominal fat, wings, and the remainders of the carcass. Individual carcass components were weighed and their percentage in the weight of eviscerated carcass with neck was calculated. Immediately after slaughter, sections of the *musculus pectoralis superficialis* were taken for histological examination from 10 birds of each colour variety and frozen in liquid nitrogen (-196^{o}C). The muscle slices were cut into 10 μm sections on a Leica cryostat at -25^{o}C. The cuts were subjected to NADH-TR histochemical reaction according to DUBOWITZ *et al*. (1973). This staining distinguishes two types of muscle fibres. White fibres with low NADH-TR activity stain light blue, and red fibres with high NADH-TR activity stain dark blue. Muscle fibre diameters were measured using a lanameter (made in Polskie Zakłady Optyczne, model MP 3/1005), and muscle fibre percentages were calculated with the use of a Nikon microscope.

The percentages of white and red fibres were determined by calculating the number of fibres in a primary muscle bundle (10 bundles per bird). The analysis was performed at the Departments of Animal Biotechnology (Division of Animal Histology) and Poultry Breeding of the University of Technology and Life Sciences in Bydgoszcz.

The numerical data were analysed statistically in an Excel spreadsheet. Means ($\bar{x}$) and standard errors (SE) were calculated for the analysed traits. The significance of differences in the analysed traits between the guinea fowl varieties was measured using analysis of variance and Student's *t*-test.

Results

Compared to grey guinea fowl, white guinea fowl consumed less feed to 14 weeks of age, but were characterized by poorer feed conversion rate per kg weight gain to 8 weeks of age and throughout the rearing period (Table 1).

Table 1

Feed consumption and conversion by guinea fowl during the rearing period

Age in weeks	Feed consumption per bird (g)		Feed conversion (g/kg gain)	
	variety			
	white	grey	white	grey
1-8	2173	2250	3449	3243
9-14	3900	3994	6870	6916
1-14	6073	6244	5070	4912

The grey guinea fowl whose postmortem traits were analysed at 14 weeks had significantly ($P \leq 0.05$) higher body weight, wings weight and weight of leg muscles compared to white guinea fowl. This was reflected in the significantly ($P \leq 0.05$) higher percentage of wings and leg muscles in the carcasses of grey compared to white guinea fowl, despite the similar dressing percentage in both varieties (Table 2).

Females of the white variety had significantly greater weight of breast muscles compared to males. This was the only statistically significant difference in postmortem traits between males and females within the analysed colour varieties.

Table 3 lists the diameters and percentages of white (αW) and red fibres (βR) in the breast muscle of both colour varieties of guinea fowl aged 14 weeks. Grey guinea fowl had a significantly ($P \leq 0.05$) greater proportion of white fibres compared to white guinea fowl. The proportion of red fibres in the breast muscle of grey guinea fowl was significantly lower compared to that in white guinea fowl.

The diameter of white fibres in the *musuclus pectoralis superficialis* was significantly ($P \leq 0.05$) higher in grey compared to white guinea fowl. Red fibres had a significantly greater diameter in the breast muscle of white compared to grey guinea

Table 2

Body weight and carcass composition in 14-week-old white and grey guinea fowl

Trait		Variety					
		white			grey		
		total	males	females	total	males	females
Weight (g)							
Body	$\bar{x}$	1270[a]	1268	1272	1302[b]	1318	1286
	SE	8.40	6.80	7.40	10.30	10.40	5.50
Dressing percentage (%)	$\bar{x}$	70.01	69.12	70.90	69.46	69.36	69.55
	SE	0.50	0.46	0.26	0.31	0.31	0.32
Carcass	$\bar{x}$	889.0	877.0	902.0	904.0	914.0	894.0
	SE	0.90	0.90	0.60	0.90	1.00	0.60
Neck	$\bar{x}$	44.0	44.0	43.0	43.0	40.0	46.0
	SE	0.56	0.40	0.55	1.49	1.63	0.52
Wings	$\bar{x}$	115.0[a]	115.0	115.0	128.0[b]	126.0	129.0
	SE	1.27	1.53	0.85	3.16	4.18	1.50
Breast muscles	$\bar{x}$	246.0*	238.0	255.0	249.0	252.0	247.0
	SE	4.36	3.99	1.98	5.35	7.49	1.82
Leg muscles	$\bar{x}$	187.0[a]	188.0	185.0	211.0[b]	212.0	210.0
	SE	5.85	5.35	4.88	4.47	5.23	2.91
Skin with fat	$\bar{x}$	61.0	62.0	60.0	57.0	51.0	62.0
	SE	3.10	3.39	2.23	4.65	5.10	2.72
Remainders	$\bar{x}$	236.0	230.0	244.0	216.0	233.0	200.0
	SE	4.03	4.22	2.12	12.3	13.4	5.06
Proportion in carcass (%)							
Neck	$\bar{x}$	4.94*	5.02	4.76	4.76	4.44	5.14
	SE	0.07	0.06	0.05	0.19	0.20	0.09
Wings	$\bar{x}$	12.93[a]	13.11	12.75	14.16[b]	13.80	14.43
	SE	0.22	0.28	0.09	0.31	0.30	0.10
Breast muscles	$\bar{x}$	27.67	27.13	28.27	27.54	27.57	27.63
	SE	0.40	0.32	0.50	0.51	0.60	0.10
Leg muscles	$\bar{x}$	21.03[a]	21.44	20.51	23.34[b]	23.19	23.48
	SE	0.58	0.50	0.54	0.56	0.62	0.45
Skin with fat	$\bar{x}$	6.86	7.07	6.67	6.31	5.58	6.94
	SE	0.36	0.38	0.26	0.48	0.51	0.37
Remainders	$\bar{x}$	26.57[a]	26.23	27.04	23.89[b]	25.42	22.38
	SE	0.30	0.26	0.33	1.36	1.64	0.45

a, b – values in the rows with different letters differ significantly between varieties ($P \leq 0.05$).

* statistically significant differences between males and females within variety ($P \leq 0.05$).

Table 3

Percentage and diameter of white (αW) and red (βR) fibres in bundles of the *musculus pectoralis superficialis* in 14-week-old white and grey guinea fowl

Guinea fowl variety		Content (%)		Diameter (m)	
		αW fibres	βR fibres	αW fibres	βR fibres
white	$\bar{x}$	67.09[a]	32.91[a]	52.94[a]	39.45[a]
	SE	0.32	0.32	0.24	0.68
grey	$\bar{x}$	69.08[b]	30.91[b]	53.26[b]	36.92[b]
	SE	0.18	0.18	0.40	0.31

a, b – values in the columns with different letters differ significantly between varieties ($P \leq 0.05$)

fowl. The standard errors for both fibre types are low, which shows that the diameters and percentages of red and white fibres in the *musculus pectoralis superficialis* of white and grey guinea fowl are quite uniform.

Discussion

The analysed birds were characterized by poorer feed conversion compared to young guinea fowl investigated by FRĄTCZAK *et al.* (2002) and TUFARELLI *et al*. (2007). When comparing several variants of feed formulas used in rearing guinea fowl to 12 weeks of age, FRĄTCZAK *et al*. (2002) found FCR values to range from 3.5 to 3.9 kg/kg. Guinea fowl studied by TUFARELLI *et al*. (2007) from 4 to 13 weeks of rearing consumed from 3.74 to 3.86 kg feed per kg gain. Similar feed conversion (3.7 kg feed/kg gain) was reported for guinea fowl to 15 weeks of age by DRABO (1992).

At 14 weeks of age, the guinea fowl varieties achieved higher body weight and dressing percentage compared to 16-week-old guinea fowl (1048 g, 66.0%) investigated by GILEWSKI *et al*. (1990). The same authors also found lower content of breast muscles and leg muscles in the carcasses of 16-week-old guinea fowl compared to 14-week-old birds evaluated in our study.

PUDYSZAK *et al*. (2003, 2005) analysed dressing percentage in guinea fowl aged 14, 16 and 18 weeks and found higher dressing percentage at 14 weeks (73.61%) but with lower body weight (1181 g) than in our study. Based on the dressing percentage and chemical composition of muscles at 14, 16 and 18 weeks of rearing, PUDYSZAK *et al*. (2003) recommend that guinea fowl broilers should be raised to 14 weeks of age.

The content of breast muscles in the carcasses of 14-week-old guinea fowl was 9.8% higher, and that of leg muscles 3.07% higher in white guinea fowl and 5.5% higher in grey guinea fowl compared to the values reported by PUDYSZAK *et al.* (2005). The high percentage of breast and thigh muscles in carcasses makes guinea fowl suitable for use as broilers.

Other authors (FUENTES *et al*. 1998) found a lack of sexual dimorphism in dressing percentage but a higher fat content of muscles in females compared to males aged 12 weeks. In another study (KOKOSZYŃSKI *et al*. 2011) males compared to females had lower body weight, carcass weight, dressing percentage, content of breast muscles and abdominal fat, and a higher proportion of leg muscles at 13 and 16 weeks of age.

Just as in hens, white fibres predominate in the breast muscles of guinea fowl of both colour varieties. ELMINOWSKA-WENDA (2007) reported that for hens, this content ranges from 93.23 to 100% for white fibres and from 0 to 9.02% for red fibres depending on the flock. In the study cited above, the diameters ranged from 26.95 to 49.11 μm for white fibres and from 23.03 to 36.49 μm for red fibres, and were lower than in the *musculus pectoralis superficialis* of guinea fowl analysed in our study.

The mean white fibre diameters of breast muscle from white (53.26 μm) and grey guinea fowl (52.94 μm) were similar to the white fibre diameter of breast muscle from WD-3 geese (52.86 μm). However, the diameter of red fibres was smaller in the geese than in the guinea fowl and ranged from 25.19 to 29.15 μm. The red fibre content of breast muscle was greater in the geese than in the guinea fowl and ranged, depending on the line, from 75.8 to 76.3%, and from 23.7 to 24.2% for white fibres (KŁOSOWSKA *et al*. 1998). In 7-week-old ducks from P33 and K2 conservation flocks, the proportion of white fibres in breast muscle ranges from 27 to 27.6%, and that of red fibres from 72.4 to 73%, with the diameters ranging from 24.8 to 29 μm for white fibres and from 15.4 to 16 μm for red fibres (WITKIEWICZ 1999).

In terms of breast muscle microstructure, guinea fowl differ from other poultry species. As regards the predominance of white fibres they are similar to gallinaceous poultry, while the diameter of white fibres in this poultry species is similar to that in geese.

In an earlier study, KŁOSOWSKA *et al.* (1998) compared breast muscle microstructure in White Italian geese of line WD1 selected for egg production, in White Italian geese of line WD3 selected for meat production, and in Landes geese. They concluded that the greater body weight, diameter and percentage of white fibres in the White Italian geese is evidence that they grow more rapidly than the Landes geese. HEJNOWSKA *et al.* (1999) studied two groups of quail and found an increase in the proportion of white fibres and greater diameters of red fibres in the breast muscle of the birds selected for meat production compared to general-purpose birds

In summary, grey guinea fowl slaughtered at 14 weeks of age had significantly greater preslaughter weight and their carcasses were characterized by significantly greater weight and proportion of leg muscles and wings compared to white guinea fowl. Females of the white variety had significantly heavier breast muscles compared to males. The proportion of eviscerated carcass with neck in the preslaughter weight (dressing percentage) of 14-week-old guinea fowl of both varieties was similar and exceeded 69%. The significantly greater proportion and diameter of white fibres in the *musculus pectoralis superficialis* of grey guinea fowl, along with the greater body weight of birds of this variety may be indicative of their superior meatiness compared to white guinea fowl.

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