Microstructural parameters of the breast and thigh muscules, carcass and meat quality in the heavy type of turkey female

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Background

Intensive genetic selection of turkeys has been based on rapid growth of the birds and can be related to muscle structure (Bentley, 1999). Most skeletal muscles of the birds contain a continuum of different fiber types classified on the basis of different histochemical reactions. Three major subtypes have been differentiated: fast twich and glycolytic (white, FG, II B or αW), fast twich, oxidative and glycolytic (intermediate, FOG, II A or αR) and slow-twich, oxidative (red, SO, I A or βR, (Carpenter et al. 1984, Sosnicki and Cassans, 1987, Klosowska et al. 1993). The breast muscle in turkey and poultry is special because it contains predominantly muscle fiber types with a glycolytic metabolism (Klosowska, 1984). Not only muscle fiber types but also their diameter may be closely related to breast mass and meat quality traits, especially to the tenderness of the breast meat (Grey et al. 1986). Several symptoms of focal myopathy in turkey breast muscle have been described (Sosnicki et al. 1989, Klosowska et al. 1999) as the effect of the intensive genetic selection.

Objectives

The purpose of this work has been to examine whether the genetic groups of heavy type turkey females at the age of 16 weeks altered body weight, and microstructural parameters as well as some physico- chemical traits in breast and thigh muscles.

Methods

Examinations were carried out on eighteen 16 weeks old female turkeys from three genetic groups of BIG-6, HLW and Nicholas-700. The turkeys were maintained on deep litter in accordance with the technology assumed for commercial flocks and on a 5 stage feeding programme. Immediately after slaughter samples from m. pectoralis superficialis and m. biceps femoris were taken for histological evaluation. Muscle samples were frozen in liquid nitrogen and stored until the time of analysis. The succinic dehydrogenase technique was used for muscle fiber differentiation into βR (red) and αW (white) fibers (Klosowska et al., 1993).Ten fields ($11{,}48\mu m^2 \times 10^5$) containing each fibre type were randomly selected to evaluate the proportion in muscle samples. The diameters and total number of fibres in a given area were counted using a Leica Q 500 MC computerized image analysis system. To determine the various degenerative changes in the muscle a van Gieson method was used (Klosowska et al.,1999). The relative extent of various degenerative characteristics was judged on the basis of microscopic observations of 50 muscle bundles. Scores of intensive (+++), moderate (++) and low (+) were assigned. After 24h chilling some carcass traits were measured (the percentage rate of breast and leg muscles, abdominal and intestinal fat). Protein and fat content in breast and leg muscles were determined using standard methods. Water holding capacity (WHC), values of pH_{24} and meat colour were determined according to Puchajda et al. (1999). Cholesterol content was determined by Spectrophotometer Shimadzu UV-3100 at a wavelenght of 560 nm. The data was analysed statistically by analysis of variance.

Results and discussion

As results from Table 1 show genetic groups of turkey females did not alter in the percentage of muscle fiber types and their diameters. Differences were noticed in these characteristics between the examined muscles. M. pectoralis contained less βR fibers and more αW fibers than m. biceps femoris. In two muscles βR fibers were smaller than αW fibers. M. pectoralis muscle had less fibers per unit area than m. biceps femoris. This means that pectoralis muscles had greater average muscle fiber diameters. Group HLW and Nicholas-700 showed more muscles fibers in m. biceps femoris than BIG-6 ($p<0.05$). This perhaps resulted from histopathological changes and incidence of intense atrophy fibers in m. biceps femoris in these groups of birds (Table 1). Angular fibers, atrophy and giant fibers, necrosis with phagocytosis, leucocytes infiltrations and fibrosis were observed in two muscles and in all groups of birds but in different intensity. Degenerative changes were greater in the muscles of Nicholas-700 group. In the muscles of younger turkey females (13 week old) the degenerative changes were limited to single focal changes and were related to the higher body weight (Klosowska et al. 1999). More intensive degenerative changes found Sosnicki et al. (1991) in pectoralis muscle of the 18 weeks old turkeys of Large White group and at the body weight of 13,2 kg. The genetic groups did not differ in body weight, breast and thigh muscle percentage in carcass (Table 2). But more fat deposit was found in carcass of HLW and Nicholas-700 group than in BIG-6 ($p<0.05$). The protein content in breast and thigh muscle was unrelated to genetic group. Thigh muscle contained less protein than breast muscle. The values of protein content were comparative to those of medium-heavy turkeys (Puchajda et al. 1997). Fat content in breast muscle was on low level and ranged from 0,48 to 0,96%. Thigh muscle contained more fat and in this muscle differences were also found between genetic groups. The level of fat was significantly lower ($p<0.05$) in group of Nicholas-700 group (6,58%) as compared to Big-6 (9,36%), and HLW (9,90%).

The values of cholesterol in m. pectoralis and m. biceps femoris of 16 weeks old female turkeys were below the value given by Honikel and Arneth (1996) for turkey breast (44mg/100g) and leg with skin (79 mg/100g). On the basis of physico- chemical properties such as pH_{24}, colour lightness and WHC values we did not find differences related to genetic group. The differences in these properties were related to the kind of muscle.

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Table 1. Microstructural traits of M. pectoralis superficialis and M. biceps femoris in three genotypes of turkey females at 16 weeks of age

Parameters			Genetic groups		
			BIG 6	HLW	NICHOLAS-700
Fibers		Muscle	$\bar{x}$ s	$\bar{x}$ s	$\bar{x}$ s
(%)	βR	Pectoralis	2,8 ± 1,39	2,9 ± 1,35	3,9 ± 1,95
		Femoris	30,9 ± 3,33	32,3 ± 3,31	31,9 ± 2,62
	αW	Pectoralis	97,3 ± 1,39	97,1 ± 1,35	96,1 ± 1,95
		Femoris	69,1 ± 3,33	67,7 ± 3,31	68,1 ± 2,62
(μm)	βR	Pectoralis	45,3 ± 9,79	53,4 ± 16,28	52,3 ± 14,45
		Femoris	56,8 ± 2,46	52,2 ± 3,98	56,1 ± 5,15
	αW	Pectoralis	61,4 ± 1,40	63,1 ± 3,61	64,1 ± 1,49
		Femoris	69,9 ± 3,71	65,0 ± 7,75	61,0 ± 4,26
Fibers / unit area		Pectoralis	155,8 ± 24,92	165,7 ± 40,30	140,2 ± 11,57
		Femoris	171,0[a] ± 18,58	220,5[b] ± 38,51	220,3[b] ± 24,29
Percentage of turkeys with histopathological changes	Angular fibers	Pectoralis	100 +	100 +	33,3 ++
		Femoris	100 +	100 +	0
	Atrophy fibers	Pectoralis	33,3 ++	50 ++	66 +++
		Femoris	83,3 ++	100 +++	100 +++
	Giant fibers	Pectoralis	100 +	100 +	33,3 +++
		Femoris	100 +	20 +++	16,6 +++
	Necrosis with phagocytosis	Pectoralis	100 +	33,3 ++	50 +++
		Femoris	100 +	100 +	20 ++
	Inflammatory	Pectoralis	0	0	0
		Femoris	0	0	0
	Fibrosis	Pectoralis	100 +	100 +	25 ++
		Femoris	100 +	80 ++	100 +

Statistically significant differences are marked by: a,b at $p<0.05$

Table 2. Body weight, carcass composition and physico-chemical properties of breast and thigh muscles in three genotypes of turkey females at 16 weeks of age

Characteristics		Genetic groups					
		BIG 6		HLW		NICHOLAS-700	
		$\bar{x}$	CV	$\bar{x}$	CV	$\bar{x}$	CV
* Body weight before slaughter, kg		10,14	6,52	9,99	7,71	9,97	6,31
* Breast muscle, %		25,52	4,54	25,25	5,09	26,25	4,28
* Thigh muscle, %		19,72	4,61	18,00	5,56	17,73	4,77
* Total fat, % (abdominal, intestinal)		1,90[a]	26,17	2,34[ab]	24,28	2,62[b]	22,30
* Total protein, %	Breast	24,15	1,58	23,65	2,01	24,07	2,27
	Thigh	18,78	3,54	18,73	4,45	19,26	3,66
* Fat, %	Breast	0,48	37,66	0,96	41,22	0,83	74,40
	Thigh	9,36[a]	32,46	9,90[a]	17,30	6,58[b]	21,01
Cholesterol, mg/100g in muscle	Pectoralis	29,34	20,62	27,57	15,01	29,19	17,58
	Biceps femoris	38,26	12,73	37,06	15,14	39,29	15,02
* pH_{24}	Breast	5,87	1,39	5,75	1,46	5,80	1,54
	Thigh	6,35	2,17	6,28	1,86	6,27	1,30
* Colour lightness, %	Breast	23,00	16,27	26,67	12,02	23,17	9,22
	Thigh	20,33	19,09	19,83	8,68	18,67	11,07
* WHC, cm^2	Breast	6,35	17,18	6,87	9,57	6,24	13,19
	Thigh	5,79	12,78	5,10	24,14	5,12	30,45

Statistically significant differences are marked by: a,b at $p<0.05$
* These results were published (Puchajda et al. 1999)

Conclusions

1. Muscle fibers types their diameter and number may by responsible for physico-chemical differences found between breast and thigh muscles.
2. A higher intensity of histopathological changes (atrophy, giant fibers, necrosis with fagocytosis) in the pectoralis and biceps femoris muscles of the Nicholas-700 group may suggest a greater predisposition in this group to environmental factors during growth.
3. It is necessary to emphasize the high content of fat in thigh muscle and very low content of cholesterol in m. pectoralis and m. biceps femoris of heavy type female turkeys at 16 weeks of age.