Muscle fiber types and histopathological changes in pectorolis muscle of the geese different genotypes

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Background

The poultry industry has improved the growth rate, meat yield and feed conversion ratio of its meat type birds. The rapid growth rate may be partly responsible for an increased incidence of focal degenerative myopathy in the skeletal muscle in some species poultry (Sośnicki et al. 1988). In some cases, degenerative characteristics may be detected microscopically in the muscle of domestic turkey (Sośnicki et al. 1988, Kłosowska et al. 1997) and of chicken (Soike, 1995) even though the birds have no visibly detectable mobility or postural problems, and the meat from them has a normal appearance (Sośnicki et al. 1988).
The geese also plays an important role because of its tasteful meat and more efforts are necessary to improve carcass and meat quality (Pingel, 1993). Selection for the improvement of goose meatness (Mazanowski et al., 1986, Rosiński and Wężyk, 1989, Rosiński and Bieliński, 1990, Rosiński and Wężyk, 1993), acceleration of the growth rate may be responsible also for the incidence of histopathological change in muscle structure.
It requires complementary searches and the application of the same criteria to the examination of goose raw material by histological methods as were applied to other poultry species.

Objectives

The aim of the present study was to determine the muscle fiber types, their diameters and the kind of pathological characteristics in pectoralis muscle of several strains of geese with different growth rates and maintaining system.

Methods

The examinations were carried out on 32 ganders which originated from 6 strains, in two experiments. Experiment A was carried out on 12 White Italian geese of 17 weeks old from two strains: WD1 (6 males) selected for egg production and WD3 (6 males) selected for meatness. The geese were kept and fed according to standard Polish technology (Bieliński 1983). Until 3 weeks of age the geese were fed with a full diet mixture ad libitum. From 4 to 14 weeks of age the geese were fed with the mixture on the level of 200 to 250 g/day and with additional green grass ad libitum. The last 3 weeks the geese received only the oat ad libitum. The ganders were housed in the groups of 60 individuals until 6 weeks of age. After that time the males were moved in the same groups to an open area.

Experiment B was carried out on 20 ganders of 16 weeks old of several experimental strains:

ND12 - crossbreed: White Italian x Kuban; ReD01 - Renen geese; WRe21 - crossbreed: White Italian x Renen; WD02 - White Italian geese.

The ganders were kept according to zootechnical norms. Until 6 weeks of life the birds were housed in a closed room with regulated environmental conditions. After that time the males were moved to an open area. Until 3 weeks of life the birds were fed with a full diet mixture (21.55% total protein and 2,829 Mcal ME). From 4 to 6 weeks the ganders received ad libitum the feed containing 95% mixture and 5% of dry grass. For histological examinations muscle samples form m.pectoralis superficialis were obtained immediately after the exsanguinations of the birds at 17 weeks of age (experiment A) and at 16 weeks of age (experiment B). Samples were frozen directly in liquid nitrogen. The muscle samples were cut in cryostat on 10 μm thick sections. Histochemical reaction was conducted in order to show the activity of succinic dehydrogenase (Dubowitz et al., 1973). The fibers were classified into red (βR) and white (αW) fibers. Fiber diameters were determined by image analysis system (Imager 512). To determine the various degenerative changes in the muscle the sections were stained by van Gieson method (Dubowitz et al., 1973). The relative extent of various degenerative characteristics was judged on the basis of microscopic observations of 50 muscle bundles. Scores of moderate (++), low (+) were assigned. Least squre analysis of variance of the data was used. Means were compared using Duncan's multiple range test.

Results and Discussion

Body weight was greatest in ganders of WD1 and WD3 strains, the lowest values showed ND12 strain (Table). The differences were statistically significant at $p<0.01$. In the percentage of muscle fiber types between strains significant differences ($p<0.05$) were also found. The greatest percentage of βR fibers (75.1%) and the lowest αW fibers (24.3%) showed WD1 strain. In the other groups βR fiberes were near in the same level from 72.1% to 73.9% and αW fibers from 26.1% to 27.9%. Less βR fiberes (52%) and more αW fiberes (48%) found Uhrin (1995) in m. pectoralis major of Ivagees geese of 10 weeks of age. More αW fibers in the muscles might indicate a faster growth rate and transformation of βR fibers dependent from oxidative metabolism into fibers developing a substantial capacity for glycogenolytic metabolism (Ashmore and Doerr, 1971). In muscle fiber diameters differences were also found between examined strains . The greatest βR fiber diameters were for WD1 strain (29.2 μm.) and the least for ReD01 strain (25.5μm.). In the other groups diameters of βR fibres were from 26.1μm. to 27.9μm. The greatest diameter of αW fibers (59.1 μm.) showed ND12 strain and the least (51.1μm.) WD3 strain. It is very interesting to note that in experiment B where ganders were one week younger then the males in experiment A the diameters of αW were in one case on the same level and in several cases significantly greater than in the birds of experiment A. This could be explained by the different feeding system. Histopathological changes in pectoralis muscle of the geese included atrophy fibers, giant fibers, necrosis with phagocytosis, infiltration of leucocytes within the perimysium and endomysium, an increase in the endomysial and perimysal connective tissue. The percentage of geese with pathological changes and the extent of theese disorders are illustrated in Table. In experiment A in two strains all the mentioned pathological changes were seen to a different extent. More extent changes included atrophy fibers, giant fibers and fibrosis. More extensive inflamatory characteristics were noticed in experiment B especially in strain WD02, ReD01 and ND12. The same

pathological changes were in muscle tissue in domesticated species of the birds more frequently in turkey and broiler hens, less often in geese and duck (Uhrin, 1985). The myopathy was originally detected in a flock of chickens (Asmundson and Julian, 1956) and turkey (Wilson, 1990) that had been expressly selected for an increase in muscle growth. The degenerative alterations noted in the current study are similar to „relative ischemia" described in turkey muscle (Sośnicki et al. 1991).

Conclusions

1. In the proportion and diameters of fiber types of pectoralis muscle significant differences were found in relation to goose genotype.
2. A greater number and greater diameters of αW fibers indicate faster muscle growth.
3. The difference in degenerative changes of the pectoralis muscle were related to differences between feeding systems.
4. In geese with faster growth there is a more frequent incidence of leucocyte infiltration in the perimysium and endomysium.
5. Degenerative changes in goose pectoralis muscle were moderate in scale .

Pertinent literature

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Table

Body weight and microstructural characteristics of pectoralis superficialis muscle in the ganders of different genetic groups

Genetic group characteristics		Experiment A		Experiment B			
		WD1	WD3	WD02	ReD01	ND12	WRe21
Age, weeks		17	17	16	16	16	16
Body weight, kg		6.50^{B}±0.1	6.92^{A}±0.9	5.90^{C}±0.5	5.90^{C}±0.3	5.50^{C}±0.6	5.90^{C}±0.5
Muscle fiber types, %	βR	75.7^{a}±8.1	73.9^{a}±9.3	72.8^{b}±9.8	72.5^{b}±11.2	72.1^{b}±10.3	73.4^{a}±9.5
	αW	24.3^{a}±8.1	26.1^{a}±9.3	27.2^{b}±9.8	27.5^{b}±11.2	27.9^{b}±10.3	26.6^{a}±9.5
Muscle fiber diameters, μm	βR	29.2^{a}±10.0	26.2^{ab}±6.6	26.3^{ab}±8.5	25.5^{b}±8.4	26.9^{ab}±8.8	26.1^{ab}±8.9
	αW	52.9^{a}±8.7	51.1^{a}±8.5	56.3^{ab}±4.0	57.8^{b}±4.8	59.1^{b}±6.6	52.3^{a}±0.9
Percentage of ganders with histopatological changes	Atrophy fibers	79.2 ++	87.5 ++	20.0 +	20.0 +	20.0 +	20.0 +
	Giant fibers	50.0 ++	56.3 ++	20.0 +	0.0	0.0	40.0 +
	Necrosis with phagocytosis	20.8 +	18.8 +	40.0 +	40.0 +	0.0	0.0
	Inflamatory	12.5 +	6.3 +	60.0 ++	60.0 ++	60.0 ++	20.0 ++
	Fibrosis	58.3 +	68.7 +	20.0 +	20.0 +	20.0 +	40.0 +

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

by : A, B, C at $p < 0.01$

Extent of histopathological changes:

\+ low

++ moderate

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	αW	$52.9^{a}\pm8.7$	$51.1^{a}\pm8.5$	$56.3^{ab}\pm4.0$	$57.8^{b}\pm4.8$	$59.1^{b}\pm6.6$	$52.3^{a}\pm0.9$
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