MICROSTRUCTURE OF GEESE PECTORALIS MUSCLE AS RELATED TO SOME MEAT CHARACTERISTICS

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SUMMARY

Histochemical and histological properties as well as some meat quality traits were determined for the pectoralis major muscle of the White Italian geese of the four genotypes: WD 1, WD 3 and their crosses WD 13 and WD 31. Differences were observed among genetic groups and sex for muscle fiber type and muscle fiber diameters but any significant differences were found in the intramuscular fatty tissue. A higher proportion of white fibers was observed in the male WD 3 strain and cross WD 13 (male and female). The higher proportion of white fibers and greater white fiber diameters showed the tendency to relationship with higher protein and moisture content of the meat. It was found on the panel score that lower tenderness of the meat was related with greater diameters of the red fibers, but on the shear force determination that one was related with lower diameters of white fibers. The intramuscular fatty tissue content was associated with emulsion stability of the meat homogenate.

Introduction

Various workers have reported that muscle quantity and quality of duck and chicken pectoral muscles were influenced by the proportions of the muscle fiber types and their diameters (Jacob and Nair, 1975, Klosowska et al.1979, Smith et al.1993). Recently, work has been done on histological characteristics of pectoralis muscle of White Italian geese, two strains selected for meatiness and egg production (Klosowska et al.1993). This study provided information that faster growth of the geese was associated with higher content of the glycolytic type muscle fibers (white) and with greater muscle fiber diameters.

In the research into the problem of the meat quality in the White Italian geese (Skrabka-Blotnicka et al.1993) it was established that sex and genotype influenced the examined functional properties of goose breast muscle.

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The purpose of this study was to determine the celluar response of skeletal muscle to selection on the maximum level of the productivity. We decided to characterize muscle fiber types, muscle fiber diameters and intramuscular fatty tissue content in pectoralis muscle from White Italian geese of the four genotypes in association with the widest, possible variation of meat quality properties determined by Skrabka-Blotnicka et al.(1992).

Materials and Methods

Histological and histochemical studies were carried out on 48 White Italian geese of 17 weeks old. At 17 w, the geese weighted from 6.03 to 7.02 kg. The geese were performed at the Koluda Wielka Experimental Station. The birds were allotted into four groups: strain WD 1 (6 males and 6 females) selected for egg production, strain WD 3 (6 males and 6 females) selected for meatiness, cross WD 13 (male WD 1 x female WD 3, 6 males and 6 females), cross WD 31 (male WD 3 x female WD 1, 6 males and 6 females).

Muscle samples were obtained immediately after the birds were exsanguinated. Samples from pectoralis major muscle were taken from the left side, just lateral to the anterior edge of the sternum. Samples were frozen directly in liquid nitrogen. Serial sets of transverse sections were cut with a cryostat. Sections were reacted for succinic dehydrogenase (SDH). Other serial sections were stained with oil red O for intramuscular fatty tissue examinations (Dubowitz et al. 1973).

Difficulties were encountered in our attempts to classify β R, α R and α W fibers for Pectoralis muscle of the geese using the procedure of Wegner et al.(1993). Therefore, we classified the fiber as either oxidative-red (β R and α R) or glycolytic-white fibers (α W).

Fiber diameters and fatty tissue area in the muscle were measured by Image Analysis System (Imager 512).

The properties of the meat: protein, moisture, fat, pH, water holding capacity, cooking loss, emulsion stability were determined by Skrabka-Blotnicka et al.(1992,1993).

Texture of cooked meat was evaluated by 8 to 11 member trained sensory panel who rated the samples on the scale from 0 to 10, it means the rate of scale of desirability (0 = extremely tough to 10 extremely tender - Skrabka-Blotnicka, 1992).

Means were compared using Duncan's multiple range test and simple correlation coefficient.

Results and Discussion

Total body weight in four genetic groups of White Italian geese are shown in Table 1. Body weight of the strains WD 1 selected for egg production was lower than WD 3 selected for meatiness and of the male of the crosses WD 13 and WD 31. Generally means values for total body weight of the males was significantly ($P<0.01$) greater when compared to females.

The histological parameters of Pectoralis muscle of the geese are shown in Table 2. The percentage of white fibers in goose Pectoralis muscle was 73.9% and 80.3% and of red 19.7% and 26.1%. For all genotypes of the geese, the differences in their percentage of oxidative (red) and glycolytic (white) fibers were found. Oxidative fiber percentage was greater ($P<0.01$) for WD 1 strain (79.7% females) and for WD 31 (80.3% males) than for the other groups. Similarly to results for WD 31, Kiessling (1977) and Uhrin and Kuliskova (1984) reported that goose Pectoralis muscle contained 83% and 81% of red fibers, and 17% and 19% white fibers, respectively.

Muscle fiber diameters, both oxidative and glycolytic ones also differed with the genotype group. The least diameters of red fibers (23.3 μm) and white fibers (51.4 μm) was found in Pectoralis muscle of the females of the strain WD 1. The greater diameters were found in muscles of the females of the strain WD 3 and cross WD 13 (25.2 μm and 53.8 μm, respectively). The greatest muscle diameters of the both fiber types were observed in Pectoralis muscle of the males of the strain WD 1 29.2 μm red fibers and 52.9 μm white fibers. Generally, the males showed greater red fiber diameters ($P<0.01$) than females (Table 3).

The intramuscular fatty tissue content in Pectoralis muscle is presented in Table 2. We didn't find statistically significant differences between four genotype groups in the fatty tissue area and percentage. In Pectoralis muscle of White Italian geese intramuscular fatty tissue area and percentage is contained at 1340.1 μm^2 to 2763.3 μm^2 and at 10.4% to 15.4%, respectively.

The chemical analysis of goose Pectoralis muscle are presented in Table 4. Contents of protein, moisture and fat were recorded at 21.7% to 22.9%, 73.5% to 74.3% and 4.5% to 6.5%, respectively. Reports on the same analysis but for duckling Pectoralis (Smith et al.1993) showed the lower protein content (19.5%), the higher moisture (77.7%), and lower lipid content (2.3%).

Skrabka-Blotnicka et al.(1993) found that breast muscle from male White Italian geese were characterized by lower water holding capacity and higher cooking loss than females as well as worse ability to oil retainment of meat homogenate.

Correlation coefficients between histological parameters and meat quality traits are presented in Table 5. Such chemical traits as protein and moisture showed the tendency to relationship with percentage of muscle fibers and their diameters. It can be said, that greater white fiber content and greater their size was related to higher protein concentration, higher moisture and lower fat content.

Sensory panel tenderness ratings was associated with diameter of red fibers ($r=0.77$) and was in agreement with others (Calkins et al.1981, Seideman, 1986, Gwartney et al.1992) who found the relationship between size, type of muscle fibers and their tenderness. Also importance of the cooked meat microstructure to the tenderness was confirmed by Grey et al.(1986) on the taste panel score of the turkey breast muscle. His results showed that tender meat contained small and densely packed fibers.

In our results on the instrumental texture properties we found the negative correlation (r=-0.79) between shear force determination and diameters of white fibers. It may suggest that tender meat of the geese is related to greater diameters of white fibers.
In some paper (Whipple et al. 1990) no significant relationship was confirmed between shear force and muscle fiber traits.

It is difficult to explain the negative correlations between water holding capacity, cooking loss and diameters of white fibers. Further studies are necessary to ascertain the reason of that.

Good agreement was found between stability of emulsion and intramuscular fatty tissue (r=0.82). The better emulsion stability was noticed in meat homogenate from muscles with greater content of intramuscular fatty tissue.

The results provided information about importance of muscle structure to functional properties of goose breast muscle. Further research is needed to clear some contradictory relations between histological parameters and meat quality traits.

Conclusions

1. The genetic and sex factors determine cellular characteristics and body size of White Italian geese.
2. Faster growth of the birds is related with higher content of glycolytic (white) muscle fibers and with greater fiber diameters.
3. The increase of white muscle fiber diameters and percentage shows the tendency to increase of protein in breast muscle.
4. The tenderness of Pectoralis muscle of the geese is related to muscle fiber diameters.
5. The intramuscular fatty tissue content is related to emulsion stability of the meat homogenate.

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