Age-related changes in tissue component distribution in Muscovy duck carcasses

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Introduction

Studies on the growth and development of domestic fowls are very important, both from the biological and the economic perspective. Age-related changes in their body weights are usually closely related not only with proportions of body parts, but also tissue components in the carcass (Bochino et al., 2003).

Generally, the most dynamic age-related changes are observed in the carcass contents of legs and breast, and the slightest – in the percentages of back and neck. However, particular species of domestic fowls differ considerably in this respect (Liesson et al., 1982; Pingel, 1990; Bochino and Brzozowski, 1998). In waterfowl the leg content of the carcass decreases systematically, whereas its breast content increases. In Muscovy ducks aged from about 7 to 13 weeks the relative leg content (expressed as a percentage of body weight) decreases only slightly, whereas, breast content increases considerably (Ricard, 1986; Pingel, 1990; Sauveur and Carville, 1990). This results from intensive development of breast muscles observed in this period, especially in Muscovy drakes (Romboli and Avanzi, 1980; Leclercq and Carville, 1986; Romboli et al., 1991). Also, in geese breast growth is connected with a high percentage of breast muscles, noted at 12 weeks of age (Janiszewska, 1993; Lewczuk et al., 1993).

Age-related changes in the percentages of meat, fat with skin and bones in carcasses of particular species of domestic fowls are characterized by various intensities. The percentages of meat and fat with skin increase, whereas, the percentage of bones decreases as birds become older (Bochino and Lewczuk, 1986; Bochino et al., 1993; Lewczuk et al., 1994). These changes are more radical in ducks (Bochino and Lewczuk, 1986) and geese (Janiszewska, 1993) than in chickens (Bochino and Brzozowski, 1998) or turkeys (Lewczuk et al., 1994).

Available literature (Leclercq and Carville, 1986; Ricard, 1986; Sauveur and Carville, 1990) doesn’t include any detailed results concerning the distribution of tissue components in carcass parts in Muscovy ducks depending on age. Therefore, the aim of the study was to analyze age-related changes in the distribution of meat, fat with skin and bones in carcasses of Muscovy ducks.

Material and Methods

The experiment was performed on 300 (sex ratio 1:1) R-31 Muscovy ducks (two-strain crossbreeds – males of the Dominant line, females of the Dynamic line of Grimaud Company), reared to 16 weeks of age. The rearing conditions were consistent with the technological standards recommended for this species. Until the end of the 3rd week of rearing the experimental ducks were fed a complete starter diet (crumbled), containing 20.16% of protein and 13.22 MJ of metabolizable energy, and from the 4th to 16th week – a finisher diet (pelleted) containing 17.98% of protein and 12.06 MJ ME.

The ducks were weighed on an individual basis at 14-day intervals. Starting from the 2nd week, 12 males and 12 females selected at random were slaughtered. The carcasses were plucked and eviscerated. Then the heads, shanks and wing-tips were cut off. Chilled carcasses (ca. 24 h, 4°C) were divided into the following elements: neck – along the line joining the edges of the coracoids; wings – in the shoulder joints; legs – in thigh joints, from the pubis process, through the groin towards the back; in order to separate thigh muscles from the carcass a cut was made on the back, along the backbone, starting from the anterior edge of the pelvis; breast – along the line running from the pubis process through costal cartilages to the superior coracoid process; the back and lumbar part was the remaining part of the carcass. These parts were dissected into meat, skin with subcutaneous and intermuscular fat, and bones.

A relative index of body weight growth rate (tw %) was calculated from the formula:

\[ t_w = \frac{W_2 - W_1}{0.5(W_1 + W_2)} \times 100\% \]

W1 – body weight at the beginning of the period analyzed, W2 – body weight at the end of the period analyzed.

Statistical analysis (Statsoft, Inc, 1995) of the material collected included the determination of arithmetic means (x) and coefficients of variation (v) of the weights of body, carcass and particular tissue components in the carcass, and the significance of differences between means for these parameters in age groups (analysis of variance in a one-factor design, F and D tests) and sex groups (t test);

percentages of particular tissue components in the carcass; age-related changes in the distribution of meat, fat with skin and bones in particular carcass parts; the total

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weight of a given tissue component in the carcass was assumed as percentage.

Results and Discussion

Over the rearing period the body weights of the experimental males increased on average from 52.2 g on the first day to 5,413 g at the age of 16 weeks; the body weights of the females increased in this period from 49.7 g to 3,030 g (Figure 1). From the 2nd week of rearing the differences in body weights between males and females were becoming more and more visible, which is consistent with the results reported by Leclercq and Carville (1986), Sauveur and Carville (1990), Baeza et al. (1999), Maruyama et al. (1999) and Gorski et al. (2000). The highest relative body weight growth rate (above 100%) was noted in the first four weeks in both males and females (Figure 1). Slower, but still intensive body weight growth was observed until about 10 weeks of age in females and 12 weeks in males. Then the growth rate index decreased considerably.

Body weight and growth rate depend, among others, on the species. Young Muscovy and Pekin ducks, as well as geese grow much faster (Knizetova et al., 1991a; Janiszewski, 1993; Wiederhold and Pingel, 1997; Baeza et al., 1998; Gille et al., 1999; Gorski et al., 2000) than broiler chickens (Leeson and Summers, 1980a; Pasteur and Shalvey, 1983; Knizetova et al., 1991b) and faster than turkeys (Leeson and Summers, 1980b; Lewczuk et al., 1994; Bocchio and Brzozowski, 1998). As a result of such differentiated growth rates, the body weight of waterfowls at slaughter age constitutes approx. 70-80% of the body weight of adult birds, whereas in broiler chickens slaughtered at six weeks of age – only 40% (Pingel, 1990).

A similar tendency as in body weights was also noted in carcass weights (Table 1). Carcasses of males were heavier than those of females. The average difference varied from 32.5 g at 2 weeks of age to 1,670 g at 16 weeks. The ratio between the carcass weights of males and the carcass weights of females was 1.16 at the beginning of the rearing period and 1.82 at its end. Meat weight increased from 79 g in carcasses of 2-week-old males to 1,945 g in 16-week-old ones, and from 70 to 1,037 g in females. Similarly as carcass weights, also the ratio between the meat weight in male carcasses and the meat weight in female carcasses changed over the experimental period – from 1.13 at two weeks of age to 1.87 at 16 weeks. In both sexes meat weight was growing fast between two and four weeks of age – it increased threefold over this period (Table 1).
Also Ziegler et al. (1985), Górski and Witak (1995) reported the highest meat weight growth at the beginning of the rearing period of Muscovy ducks. In the last two weeks (14 - 16) the increase in meat weight was slight, although in males its value was still statistically significant. Bone weight was increasing to 10 weeks of age in females, from 40 to 254 g, and to 12 weeks in males, from 51 to 505 g. Then its growth was stopped. The deposition of skin with fat is still intensive in this period.

Figures 3, 4 and 5 present the distribution of meat, skin with fat and bones respectively in carcass parts. The contents of individual tissue components are expressed as percentages, and the weight of a given tissue component in the whole carcass, at a given age, was assumed as 100%.

In both males and females aged two weeks, half of the total meat weight (48.8 and 51.3% respectively) was located in the legs – Figure 3. The meat content of the back was also relatively high (♂ 28.8 and ♀ 27.0%). The least meat was located in the wings (♂ 2.75%). The meat content of the neck and breast was at a similar level in both males and females (ca. 10 and 9% respectively). Considerable changes in meat distribution were noted in females aged 8 to 10 weeks, and in males aged 10 to 12 weeks. Its percentage decreased by half in the legs and neck, and increased in the breast and wings. The meat located in the legs and breast constituted at that time over 60% of its total content. In successive weeks the meat content of the carcass weight in both males and females aged 16 weeks. The percentage of bones in carcasses was reduced from ca. 22% in drakes and 20% in ducks in the 2nd week to 14.3% and 13.2% respectively in the 16th week. In Pekin ducks bone growth is observed to approximately 6 weeks of age (Bochino et al., 2003). In the next weeks the bone content of carcasses diminished, because growth of meat and fat with skin is still intensive in this period.
breast increased to 45.3% in males and to 48.3% in females aged 16 weeks, whereas, the meat content of the legs decreased to 14.3 and 13.6%, respectively. Differences in meat percentage in the legs and breast in Muscovy ducks are observed later than in Pekin ducks (Wawro et al., 1986; Gille and Salomon, 1998) and mule (Gille and Salomon, 1998). This is connected with a long period of breast muscle growth, especially in Muscovy drakes, as reported by Romboli and Avanzi (1980), Romboli et al. (1991), Auvergne et al. (1995), and Baeza et al., (1999). Also in young Pekin ducks breast muscles grow slower than leg muscles (Gille and Salomon, 1998). Then the growth rate of breast muscles increases significantly, and in ducks aged 8 weeks meat percentages in the legs and breast are similar (Wiederhold and Pingel, 1997). A tendency like that can also be observed in crossbred ducks (Muscovy x Pekin), which was confirmed by the studies conducted by Gille and Salomon (1998).

The meat content of the wings was increasing systematically to 12 weeks of age in males and to 10 weeks in females (Figure 3), constituting in this period ca. 12.8% of its total weight. In the 16th week the meat content of this part decreased by 0.8% in drakes, and by only 0.3% in ducks. The amount of meat located in the neck was decreasing with age in both sexes. At the end of the experiment it was on average by 5% lower than in 2-week-old birds (Figure 3). A falling tendency was also observed in the meat content of the back. In ducks aged 2 weeks meat weight in this carcass part constituted 28.8% of its total weight in males, and 27.0% in females, to drop to ca. 14% at the end of rearing.

It is difficult to compare own results with those obtained by other authors due to various methods of carcass formation (with or without neck and wing tips) and separation. However, it may be stated that in young ducks (Bochno and Lewczuk, 1986; Wawro et al., 1986; Gorski and Witak, 1995) and geese (Janiszewska, 1993) the most meat is located in the legs, whereas in older — in the breast. The pattern of meat distribution in Muscovy ducks is more similar to that in White Italian geese (Janiszewska, 1993) than in other domestic fowls (Leeson and Summers, 1980a; Leeson and Summers, 1980b; Bochno and Brzozowski, 1998).
Age-related changes in the distribution of skin with fat were smaller. This percentage increased from ca. 12% in the 2nd week to 22.2% in males and 23.5% in females aged 16 weeks. Intensive growth of bones and skin with subcutaneous fat in the wings is connected with the developing power to fly (Pingel, 1990). However, due to domestication of Muscovy ducks and selection aimed at increasing their body weights this ability underwent retardation.

The percentage of bones in the breast, in relation to their total weight in the carcass, increased somewhat (by ca. 7%) for the first 8 (males) or 10 weeks (females), and then remained at a stable level of 18.2 and 19.4%, respectively.

### Conclusions

1. Muscovy ducks are characterized by the highest growth rate in the first four weeks of rearing. Sex dimorphism can be observed for body weight and carcass weight over the whole rearing period.

2. Meat weight grows to 16 weeks of age in males and to 14 weeks in females, whereas bone weight ~ to 12 and 10 weeks, respectively. The deposition of skin with subcutaneous and intermuscular fat is rather uniform in both sexes until 14 weeks of age.

3. The distribution of tissue components in carcasses of Muscovy ducks changes with age. Leg and back muscles have the largest share in the total meat weight (50% and x > 27% respectively) in the youngest ducks, whereas breast muscles - in the oldest ones (x > 45%). Age-related changes in the distribution of skin with fat are smaller than those concerning meat. However, between 2 and 16 weeks of age their contents doubled in the wings and decreased twofold in the neck. Slightly different tendencies were noted in the distribution of bones. Their content of the wings increased over threefold. Bone growth in the breast was accompanied by a decrease in their percentages in the legs and back.

4. The length of the rearing period of Muscovy ducks should be determined not only on the basis of production costs and slaughter value, but also the distribution of tissue components in particular carcass parts.

### Summary

The aim of the study was to analyze the tissue composition and distribution of meat, fat with skin and bones in carcasses of Muscovy ducks reared to the age of 16 weeks. It was found that in males and females aged two weeks half of the total meat weight (48.8 and 51.3% respectively) was located in the legs, 28.8% in males and 27.0% in females in the back, only 2.75% in the wings. The meat content of the neck and breast was at a similar level in both males and females (ca. 10 and 9%, respectively).

In females aged 8 to 10 weeks, and in males aged 10 to 12 weeks meat translocation from the legs, back, and neck to the breast (an increase to 45.3% > and 48.3% +) and wings (an increase to ca. 12%) was observed. Age-related changes in the distribution of skin with fat were smaller. This percentage in-

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**Figure 5. Percentage of bones from particular tissue components in the total bone weight in carcasses of (a) males and (b) females**

Knochenmenge der Teilstücke im Verhältnis zum Gesamtka-
chengewicht am Schlachtkörper bei männlichen (a) und weibli-
chen (b) Enten

Analysis of bone distribution in duck carcasses (Figure 5) shows that in successive weeks of rearing their content was the highest in the back, and the lowest – in the neck. Age-related changes in bone distribution were characterized by various intensities. A falling tendency was observed in the bone content of the back and legs. In the back it decreased from 40% in the 2nd week to 30% in the 4th week, whereas in the legs – from 31.1% in 2-week-old males to 19.4% in 16-week-old ones, and from 32.1% to 19.2% in females. A rising tendency was noted in the bone content of the wings, which increased from 6.1% in the 2nd week to 22.2% in males and 23.5% in females aged 16 weeks.

Content of skin and fat in the wings is connected with the developing power to fly (Pingel, 1990). However, due to domestication of Muscovy ducks and selection aimed at increasing their body weights this ability underwent retardation.

The percentage of bones in the breast, in relation to their total weight in the carcass, increased somewhat (by ca. 7%) for the first 8 (males) or 10 weeks (females), and then remained at a stable level of 18.2 and 19.4%, respectively.

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creased in the wings, back and breast, and decreased in the neck and legs. Compared with their total weight in the carcass, the percentage of bones was decreasing quickly in the back and legs, growing fast in the wings, increasing somewhat slower in the breast, and remained at a stable level in the neck over the entire rearing period.

**Key words**
Muscovy ducks, carcass, tissue composition, age, sex dimorphism

**Zusammenfassung**

**Altersabhängige Veränderungen in der Gewebezusammensetzung von Moschusenten-Schlachtkörpern**

Das Ziel der Untersuchung war die Bestimmung der Gewebezusammensetzung und der Verteilung von Fleisch, Fett mit Haut sowie Knochen in Schlachtkörpern von Moschusenten, die bis zu einem Alter von 16 Wochen gemästet wurden. Es wurde festgestellt, dass sich bei männlichen und weiblichen Moschusenten im Alter von 2 Wochen die Hälfte der Fleischmasse (48,8 bzw. 51,3%) in den Schenkeln, 28,8% (männliche Tiere) bzw. 27,0% (weibliche Tiere) im Rücken und nur 2,75% in den Flügeln befanden. Die Fleischmenge am Hals und an der Brust war bei beiden Geschlechtern etwa gleich (ca. 10 und 9%). Bei den weiblichen Tieren wurde im Alter von 8 bis 10 Wochen und bei den männlichen Tieren im Alter von 10 bis 12 Wochen die Fleischfülle zunehmend von den Schenkeln, dem Rücken und dem Hals zur Brust (Zunahme auf 45,3 bzw. 48,3%) und zu den Flügeln (Zunahme ca. 12%) verlagert. Die altersabhängigen Verschiebungen in der Verteilung von Haut mit Fett fielen dagegen geringer aus. Dieser Anteil nahm bei den Flügeln, dem Rücken und der Brust zu, während er beim Hals und den Schenkeln abnahm. Der Anteil der Knochen nahm im Vergleich zu ihrem Gewicht im Schlachtkörper im Rücken und den Schenkeln schnell ab, in den Flügeln schnell zu, in der Brust etwas langsamer zu und veränderte sich über die Mastdauer im Hals kaum.

**Stichworte**
Moschusente, Schlachtkörper, Gewebezusammensetzung, Alter, Geschlechtsdimorphismus

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