ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS
SBORNÍK MENDELOVY ZEMĚDĚLSKÉ A LESNICKÉ UNIVERZITY V BRNĚ

Volume LVI 13 Number 4, 2008

THE EFFECT OF GENOTYPE AND AGE ON THE CARCASS QUALITY OF BROILERS AND MALES OF THE LAYING HYBRIDS

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Received: March 25, 2008

Abstract

LICHOVNÍKOVÁ, M., JAROŠOVÁ, A.: *The effect of genotype and age on the carcass quality of broilers and males of the laying hybrids.* Acta univ. agric. et silvic. Mendel. Brun., 2008, LVI, No. 4, pp. 121–126

In the study the carcass quality of fast growing broilers (F) and slow growing layer males (S) was compared. The effect of age on the carcass quality of S (S1, S2) was also evaluated. The weights of the carcasses were as follows: F 1110 g, S at 90 days of age 1116 g (S1) and S at the age of 132 days 1878 g (S2). Despite similar carcass weight in F and S1, the weight of the breast, and it's proportion to the total body weight was significantly higher ($P < 0.001$) in F (265 g and 23.9% vs. S1 174 g and 15.6%). Continued fattening of the layer males resulted in increased breast weight (S2 276 g, $P < 0.001$) but not in breast proportion (S2 14.7%).

The weight of the legs was significantly higher ($P < 0.001$) in S1 in comparison with F, but it was due to the heavier weight of the leg bones in S1 ($P < 0.001$). There was no difference neither in the weight of the leg muscles, nor of the leg proportions between F and S1. The proportion of the leg muscles increased significantly ($P < 0.05$) in S2 (25.6%) in comparison with S1 (24.1%). The content of abdominal fat, fat in the breast and fat in the leg muscles was significantly lower ($P < 0.01$, $P < 0.01$, $P < 0.05$, respectively) in the layer males S1 in comparison with the F broilers. The proportion of abdominal fat was 1.79% in F, and 0.54% in S1. The content of the breast fat was 1.24% in F and 0.56% in S1. The proportion of fat in the leg muscles was 8.45% in F and 2.78% in S1. As the birds became older, the content of the fat increased: the abdominal fat in S2 – 1.38% ($P < 0.01$), the breast fat in S2 – 0.96% ($P < 0.01$) and the leg muscles fat in S2 – 3.94% ($P < 0.05$). There was significantly lower ($P < 0.001$) content of dry matter in S1 than in F both in the breast and in the leg muscles.

At the same carcass weight as the broilers, the layer males had a lower proportion of breast meat and also a lower content of abdominal fat, fat in the breast and fat in the leg muscles. The proportion of the leg muscles was comparable between the two groups. Concerning meat production, the quality of the carcasses of the layer males improved with age. Comparing the F carcasses with weight at 1110 g with the S2 carcass with weight of 1878 g, the weigh of the breast was almost the same, the weight of the leg muscles was higher in S2, and mainly the content of the fat in leg muscles was lower. The content of the abdominal fat and the breast fat was similar in both groups.

breast proportion, leg proportion, abdominal fat, breast fat, leg muscles fat

The antagonistic relationship between meat and egg production in the 1950´s led to the separation of the meat and egg-type strains of fowl. Consequently, the day-old male layer chickens have been used in the pet food industry as a high quality animal protein source for predators, reptiles, falcons, hawks and zoo animals. In the Czech Republic about 7 million male chicks from the laying hybrids are culled annually after hatching. In the Czech Republic the emphasis in the poultry market is on convenience products (cut ups) as well as on the cost, of raising the birds. In some other European counties, however, the emphasis in on quality birds, and good tasting meat. Also under consideration is the humane handling of the chickens. Some markets require birds form alternative system of fattening (France – Label Rouge). The fattening of the males from egg-type hybrids could provide an alternative product.

The superiority of meat-type chickens in terms of growth is well documented (Hardy et al., 1975; Gerken et al., 2003; Damme and Ristic, 2003; Lonergan et al., 2003); however there are only a few studies concerning the composition of the carcass of commercial layer males in comparison with broilers. And there are almost no studies which compare the carcass quality and composition of the meat of broilers and layer males at the same carcass weights. Gerken et al. (2003) compared the carcass quality of egg-type cockerels and male broilers, but they compared them at the same age, when broilers were significantly heavier. Lonergan et al. (2003) compared breast meat quality and its composition among different genotypes, but the birds were all the same age. Fanatico et al. (2005) and Lewis et al. (1997) evaluated the effect of genotypes on the carcass quality of the slower and faster growing birds at the same live weight (Levis et al., 1997) at the same carcass weight). In both of these cases, however, they compared fast and slower growing broilers, but no layer males.

The layer males could be used in organic farming for producing organic chicken when the fattening period is at least 81 days. The aim of the study was to compare the carcass quality of broilers and layer males at the same weight of carcasses and to evaluate the effect that the age of the layer males has on the quality of carcass.

MATERIALS AND METHODS

In the trial the carcass quality of the slow growing (S1) layer males (hybrid ISA Brown) and the fast growing broilers (F – ROSS 308) was compared when the carcasses weighed the same. The effect of the age (90 days – S1 and 132 days – S2) of the layer males on the carcass quality was evaluated, too. The carcass weight of F was 1110 g and the carcass weights of S1 and S2 were 1116 g and 1878 g, respectively. The carcasses of the birds were cut up 24 hours after slaughter. During this period they were chilled at 5 °C. The legs with the skins (thighs plus drumsticks) and the breasts without the skins were weighed. Then the legs were deboned and the leg muscles and leg bones (femur and tibia) were weighed. According to the weight of the carcasses and the weight of the parts, the proportion of the breast, leg, leg muscles and the leg bones were calculated. Also, the proportion of the abdominal fat was calculated. The raw left sides of the breasts were evaluated for chemical analysis – dry matter and fat content. The left side of the thighs and drumsticks (without the skin) were homogenized and evaluated also for these parameters. The chemical analyses of the meat were done as follows: The moisture was determined by drying the meat at 105 °C for 6 hours. The total lipids were analyzed by extraction with a petroleum ether (Soxhlet method).

The data were subjected to an analyses of variance using *Unistat 5.1* (UNISTAT Ltd, ENGLAND). Tukey-HSD was used as the post hoc test for all possible pair-wise comparisons within groups.

RESULTS AND DISCUSSION

The results of the study of the carcass quality of F, S1 and S2 are shown in Table I. The weights of the carcasses were as follows: F – 1110 g, S1 – 1116 g and S2 – 1878 g. Despite almost the same carcass weight in F and S1, the weight of the breast meat, and its proportion to the total carcass weight was significantly higher in F ($P < 0.001$). This is the result of the intensive selective breeding for this characteristic in broi-

I: *Effect of genotype and age on the carcass quality*

Carcass components		ROSS 308	ISA Brown 90 d	ISA Brown 132 d	p-values
		F	S1	S2	
Carcass weight	g	1110 ± 9.6^{b}	1116 ± 21.0^{b}	1878 ± 18.1^{a}	< 0.001
Breast weight	g	265 ± 5.2^{b}	174 ± 4.3^{a}	276 ± 4.7^{b}	< 0.001
Leg weight*	g	352 ± 5.7^{c}	396 ± 6.8^{b}	638 ± 4.6^{a}	< 0.001
Leg muscles	g	271 ± 5.1^{b}	269 ± 5.3^{b}	480 ± 6.3^{a}	< 0.001
Breast proportion	%	23.9 ± 0.46^{a}	15.6 ± 0.28^{b}	14.7 ± 0.21^{b}	< 0.001
Leg proportion	%	31.7 ± 0.46^{a}	35.5 ± 0.31^{b}	34.0 ± 0.23^{c}	< 0.01
Leg muscles proportion	%	24.5 ± 0.49^{ab}	24.1 ± 0.28^{a}	25.6 ± 0.31^{b}	< 0.05
Leg bones proportion**	%	22.9 ± 0.72^{b}	32.0 ± 0.48^{a}	24.6 ± 1.00^{b}	< 0.001
Abdominal fat proportion	%	1.79 ± 0.242^{b}	0.54 ± 0.133^{a}	1.38 ± 0.138^{b}	< 0.01
Breast dry matter	%	25.9 ± 0.17^{b}	24.0 ± 0.10^{a}	26.1 ± 0.11^{b}	< 0.001
Leg muscles dry matter	%	28.2 ± 0.31^{a}	23.2 ± 0.16^{b}	25.3 ± 0.16^{c}	< 0.001
Breast fat	%	1.24 ± 0.134^{b}	0.56 ± 0.062^{a}	0.96 ± 0.073^{b}	< 0.01
Leg muscles fat	%	8.45 ± 0.426^{a}	2.78 ± 0.166^{b}	3.94 ± 0.266^{c}	< 0.05

* Drumstick + thigh
** Femur + tibia

lers. The breasts are considered the most valuable part of the broiler carcass. The heritability of breast weight of the carcass was estimated at 0.5 (Ricard and Rouvier, 1967 in Crawford, 1993). The weight and proportion of the legs was significantly higher ($P < 0.001$) in S1 in comparison with F, but this was due to the higher weight of the leg bones in S1 ($P < 0.001$). There was no difference in the weight and proportion of the leg muscles with the skin between F and S1. Also Gerken et al. (2003) found that the proportion of the less valuable parts and the percentage of leg tended to be higher in egg-type males than in broilers, whereas the breast percentage was lower in egg-type males. They compared birds of the same age that had different carcass weights. In broilers, Fanatico et al. (2005) observed a significant effect of the genotype (fast vs slow) on the percentage of both breast and leg meat to the total weight of the carcass. In their experiment with slow growing broilers, the percentage of the breast meat was lower, but the percentage of the leg meat was higher in comparison with fast growing broilers. The quality of carcasses with the same weight of slow and fast growing broilers was compared by Lewis et al. (1997). They didn't note a significant difference in the breast, thigh, or total meat production.

Due to a higher carcass weight in S2 than in S1, also the weight of the breast was higher in S2 ($P < 0.001$), but there was no observed improvement in the proportion of the breast relative to the age of the birds. With age, the weight of the legs of S significantly increased ($P < 0.001$), but, the proportion of the weight of the legs to the carcass significantly decreased ($P < 0.01$). On the other side, the proportion of the leg bones significantly decreased ($P < 0.001$) and the proportion of the leg muscles significantly increased ($P < 0.05$) with age. In this study comparing layer males at 90 and 132 days old, the proportion of the leg muscles increased with age, but the proportion of breast meat slightly decreased. The same effect of age on the meat parts in laying-type cockerels was reported by Murawska et al. (2005), but they compared the carcass quality at 2 and 18 wks of age.

The proportion of abdominal fat, fat in the breast and fat in the leg muscles was significantly lower ($P < 0.01$, $P < 0.01$, $P < 0.05$, respectively) in the layer males S1 than in F broilers which had the same carcass weight. Also according to Lonergan et al. (2003), the breast meat of modern fast-growing broilers contained a greater percentage of lipids and a lower percentage of proteins compared with the slow-growing strains. Crawford (1993), on the basis of his scientific works, concluded that although only a few authors presented correlations greater than 0.5, they indicate that the selection of birds to increase body weight will also give rise to an increase in abdominal fatness. Havenstein et al. (1994 in Muir and Aggrey, 2003) indicated that the selection of birds based on their body weight concomitantly promoted fat accretion. Prolonged fattening of S2 layer males significantly improved the content of abdominal fat ($P < 0.05$), the fat in the breast ($P < 0.01$) and the fat in the leg muscles ($P < 0.05$) in comparison with S1. In their study Leeson and Summers (1980) had already illustrated that there was an increase in fat as growth continues. But they only used broilers in their experiment. However, the content of the fat in the heavier carcasses of S2 was still lower than that in the F broilers.

The content of the dry matter was significantly lower ($P < 0.001$) in S1 than in F in both the breast and leg muscles. In 1984 Friars (in Crawford, 1993) estimated a negative genetic correlation at –1.02 for moisture with fat, which confirms his conclusions in this study. As the birds grow older, the content of the dry matter in the breast and leg muscles significantly increased ($P < 0.001$).

At the same carcass weight, the layer males had a lower percentage of breasts meat in comparison with broilers. The proportion of leg muscles was comparable. But layer males had a lower content of fat in the carcass. The quality of S carcasses improved with age. Comparing F carcasses with a weight of 1110 g and S carcasses with a weight of 1878 g, the weigh of the breast was almost the same, the weight of the leg muscles was higher in S, and the content of the fat in the leg muscles was lower. The abdominal fat and the breast fat was comparable. The results suggest that the quality of the carcass of laying males is comparable to that of the broilers. These layer males can be used in an alternative system of production namely organic farming. In the Czech Republic there are currently no hybrid birds being used for the production of organic chick meat. This is because of the disadvantage of higher feed consumption and slower growth in comparison with special hybrids (SASSO hybrids).

SUMMARY

The aim of the study was to compare the carcass quality of broilers (F) and layer males (S) when they weighed the same, and to evaluate the effect that the age of the layer males had on the quality of carcass (S1, S2). The carcass weight of F was 1110 g and the carcass weights of S1 and S2 were 1116 g and 1878 g, respectively. After slaughter, the carcasses of the birds were chilled at 5 °C until they were cut up 24 hours later.

The total weight of the carcasses as well as the separate weight of the breast, leg, leg muscles and the leg bones was calculated. The left breast, thighs and drumsticks (without the skin) were homogenized and evaluated for dry matter and fat content. The dry matter was determined by drying the material at 105 °C for 6 hours. The total lipids were analyzed by extraction with petroleum ether (Soxhlet method).

Data were subjected to analyses of variance using *Unistat 5.1* (UNISTAT Ltd, ENGLAND). Tukey-HSD was used as the post hoc test for all possible pair-wise comparisons within the groups.

Although the weights of the carcasses from F and S1 were almost the same, the weight and proportion of the breast meat was significantly higher ($P < 0.001$) in F than it was with S1 (265 g and 23.9% vs. S1 174 g and 15.6%). The prolongation of fattening the layer males had a positive effect only on the breast weight (S2 – 276 g, $P < 0.001$), but not on the proportion of the breast to the rest of the carcass (S2 14.7%). The weight of the legs was higher ($P < 0.001$) in S1 than in F, but this was caused by a higher proportion of bones in S1 ($P < 0.001$). There was not a significant difference between F and S1 in the weight of the leg muscle with the skin in proportion to the rest of the carcass. The weight of legs and leg muscles increased depending on the age of S ($P < 0,001$). The proportion of bones to legs in S2 decreased from 32.0% in S1 to 24.6% in S2 ($P < 0.001$) and the proportion of the leg muscles to carcass increased from 24.1% in S1 to 25.6% in S2 ($P < 0.05$). The proportion of abdominal fat, fat in the breast and fat in the leg muscles was lower in S1 in comparison with F. The proportion of abdominal fat was in F 1.79% and in S1 0.54% ($P < 0.01$), and the proportion of fat in the breast was in F 1.24% and in S1 0.56% ($P < 0.01$). The proportion of fat in the leg muscles was in F 8.45% and in S1 2.78% ($P < 0.05$). With age, the proportion of abdominal fat in S increased (S2 – 1.38, $P < 0.01$), and also the proportion of fat in the breast and the leg muscles increased (S2 – 0.96%, $P < 0.01$, S2 – 3.94%, $P < 0.05$, respectively). The content of dry matter was higher in S1 in comparison with F ($P < 0.001$) in both the breast and leg muscle. With age the content of dry matter in these parts increased ($P < 0.001$).
At the same carcass weight of S and F the lower proportion of breast and lower content of fat (abdominal, in breast, in leg muscles) is characteristic for layer males. The proportion of leg muscles is comparable in both F and S. The quality of the carcass increased depending on age in S. The proportion of bones decreased with age in S. With increasing age the proportion of fat increased in S (1878 g – carcass weight) but the content is still lower than in F (1110 g – carcass weight).

SOUHRN

Vliv genotypu a věku na kvalitu jatečně opracovaného těla u brojlerů a nosných kohoutků

Cílem sledování bylo porovnat kvalitu jatečně opracovaného těla (JOT) u rychle rostoucích brojlerů (F) a pomalu rostoucích nosných kohoutků (S). Dalším cílem bylo vyhodnotit vliv věku na kvalitu JOT u nosných kohoutků. Rozbor JOT byl prováděn u brojlerů s hmotností JOT 1110 g a nosných kohoutků 1116 g (S1) a 1878 g (S2). JOT byla porcována do 24 h po porážce a během této doby byla skladována při teplotě 5 °C. Na základě hmotností prsou, dolních končetin s kostí a bez kostí a abdominálního tuku byl vypočten jejich procentický podíl z JOT. Levá polovina prsou a svalovina levé končetiny bez kůže byly homogenizovány a v těchto vzorcích byla stanovena sušina a obsah tuku. Sušina byla stanovována po 6 h vysoušení při teplotě 105 °C. Obsah tuku byl stanovován po extrakci petroléterem (Soxhlet). Data byla vyhodnocena analýzou variance programem *Unistat 5.1* a pro následné testování průkaznosti rozdílu mezi průměry byl použit Tukey-HSD test.
Přestože hmotnosti JOT u F a S1 byly téměř shodné, hmotnost prsní svaloviny a její podíl byl průkazně vyšší ($P < 0,001$) u F v porovnání s S1 (265 g a 23,9 % vs. S1 174 g a 15,6 %). Prodloužení výkrmu nosných kohoutků mělo pozitivní vliv pouze na zvýšení hmotnosti prsní svaloviny(S2 – 276 g, $P < 0,001$), nikoliv na její procentický podíl z JOT (S2 14,7 %). Hmotnost dolních končetin byla průkazně vyšší ($P < 0,001$) u S1 než u F, což bylo způsobeno vyšším podílem (hmotností) kostí dolní končetiny u S1 ($P < 0,001$). V hmotnosti svaloviny dolních končetin s kůží a v jejím podílu z JOT nebyl mezi F a S1 statisticky průkazný rozdíl. Hmotnost dolních končetin a hmotnost svaloviny dolních končetin s věkem u nosných kohoutků průkazně vzrostla ($P < 0,001$). Podíl kostí dolních končetin u S2 průkazně klesl z 32,0 % u S1 na 24,6 % u S2 ($P < 0,001$) a naopak podíl svaloviny končetin průkazně vzrostl z 24,1 % u S1 na 25,6 % u S2 ($P < 0,05$). Podíl abdominálního tuku, tuku v prsní svalovině a tuku ve svalovině dolních končetin bylo průkazně nižší u S1 než u F. Podíl abdominálního tuku byl u F 1,79 % a u S1 0,54 % ($P < 0,01$), podíl tuku v prsní svalovině byl u F 1,24 % a u S1 0,56 % ($P < 0,01$) a podíl tuku ve svalovině dolních končetin byl u F 8,45 % a u S1 2,78 % ($P < 0,05$). S rostoucím věkem nosných kohoutků se zvyšoval podíl abdominálního tuku (S2 – 1,38, $P < 0,01$), podíl tuku v prsní svalovině (S2 – 0,96 %, $P < 0,01$) a také podíl tuku ve svalovině dolních končetin (S2 – 3,94 %, $P < 0,05$). Jak v prsní svalovině, tak ve svalovině dolních končetin byl průkazně nižší obsah sušiny u S1 v porovnání s F ($P < 0,001$). S věkem se obsah sušiny v těchto částech JOT u S průkazně zvýšil ($P < 0,001$).
Při stejné hmotnosti JOT je pro kohoutky nosného typu charakteristický nižší podíl prsní svaloviny, ale také nižší obsah tuku, a to jak abdominálního, tak v prsní svalovině a svalovině dolních končetin. Podíl svaloviny dolních končetin je srovnatelný s podílem u brojlerů. Kvalita JOT s ohledem na produkci masa se s věkem zvyšuje, snižuje se především podíl kostí dolních končetin. Se zvyšujícím se věkem se zvyšuje také obsah tuku, který je ovšem i při hmotnosti JOT 1878 g nižší než u brojlerů.

podíl prsní svaloviny, podíl dolních končetin, abdominální tuk, tuk v prsní svalovině, tuk ve svalovině dolních končetin

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