# Animal welfare, etológia és tartástechnológia

# Animal welfare, ethology and housing systems

Volume 15 Issue 2

Gödöllő
2019

# EFFECT OF THE BREED ON SELECTED PHYSICAL AND CHEMICAL QUALITY CHARACTERISTICS OF LAMB MEAT.

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Received – Érkezett: 07. 11. 2019.
Accepted – Elfogadva: 17. 12. 2019.

**Abstract**

The main aim of the present study was to evaluate the effect of the breed on selected physical and chemical quality characteristics of lamb meat. An integral part of the study was an assessment of growth and basic carcass traits. Three breeds (Zwartbles (ZW), Suffolk (SF) and Oxford Down (OD) of lambs were used in the experiment, which were slaughtered at the preferred liveweight (around 38 kg). The experiment was carried out at an organic sheep farm in the northern Moravia region of the Czech Republic. The genotype had a significant effect on weights of kidney and kidney fat. The genotype had also significant effect on both conformation score (CS) and fatness score (FS). With regard to physical and chemical quality characteristics of lamb meat, the genotype had a significant effect on contents of dry matter (DM), ash, collagen, myoglobin and intramuscular fat (IMF). On the other had the genotype hand no significant effect on $pH_{24}$, water-holding capacity, lightness index (LI), redness index (RI) and yellowness index (YI). The genotype also had no significant effect on average daily gain (ADG) and dressing percentage (DP). In general, it can be stated that the highest ADG (170 g) and the best CS (3.8) and FS (2.2) were found in SF. However in ZW, which is dual-purpose breed compared to SF and OD, relatively high DP (49.2 %), low FS (2.2), relatively high contents of ash (1.12 %) and protein (19.00 %) and low content of IMF (1.74 %) were found. In these lambs were also found comparable values of LI, RI and YI with other meat breeds.
**Keywords:** Zwartbles, Suffolk, Oxford Down, quality, lamb meat

## Introduction

In the Czech Republic the consumption of pork and poultry meat per capita is dominant and the lamb meat is not a traditional food. However, in recent years its popularity has been increasing and its consumption too. In terms of preference, contrary to south European countries with their preference for meat from “light” lambs (*Díaz et al*., 2002). domestic consumer prefer meat of good conformed “heavy” lambs, slaughtered at live weights in the range from 25 to 40 kg (*Zapletal et al*. 2010). Due to this fact domestic sheep breeding is primarily focused on special meat breeds and combined, dual-purpose breeds. These breeds are also preferred among domestic breeders for their

10.17205/SZIE.AWETH.2019.2.058

good prolificacy, relatively high growth rate and resistance to unfavorable climatic conditions in mountain areas where the sheep are mainly reared.

Lamb meat quality is primarily determined by its physico-chemical characteristics, including fat content and its composition, and sensory traits (*Tejeda et al*., 2008). Lamb meat quality is affected by many factors, whilst the most important are nutrition, breed, gender, age and health status of animal. Genetic related effects on lamb meat quality have been summarised by *Hopkins et al*. (2011).

The main aim of the present study was to evaluate the effect of the breed on selected physical and chemical quality characteristics of lamb meat. An integral part of the study was an assessment of growth and basic carcass characteristics. Three breeds (Zwartbles (ZW), Suffolk (SF) and Oxford Down (OD) of lambs were used in the experiment, which were slaughtered at the preferred liveweight (around 38 kg).

## Material and methods

The experiment was carried out at an organic sheep farm in the northern Moravia region of the Czech Republic and lambs of the three breeds, Zwartbles (ZW), Suffolk (SF) and Oxford Down (OD) were used. Lambing occurred indoors, but two days after parturition all lambs with their mothers were moved on permanent pasture. All animals were reared in one flock under identical conditions without any discernible differences regarding nutrition or management. During the experiment the daily feed ratio of lambs consisted of milk, organic mineral lick and grazing on permanent pasture (all components were offered ad libitum). The weaning of all lambs was carried one day before slaughter. Live weights at slaughter and age at slaughter were recorded on the day of slaughter; average daily gains in the period from birth to slaughter were calculated. After 24 h of refrigeration (+4 °C) cold carcass weight, kidney weight and kidney fat weight were measured. Dressing percentage was calculated from the above values. The conformation score (CS, an extent of the scale from S = exceptional to P = poor conformation) and fatness score (FS, the scale from 1 = very low to 5 = very high fatness) were assessed according to the S.E.U.R.O.P. evaluation system (Commission Regulation EEC 461/93). For the purpose of statistical analysis, the scale of the CS was quantified from the grade S = 6 to the grade P = 1. At the same time (after 24 h of refrigeration), samples of the *quadriceps femoris* muscles (MQF) were taken from the right leg for subsequent analyses.

Laboratory analyses of meat were carried out in duplicate in refrigerated MQF samples. Values of $pH_{24}$ were measured by a stick probe using a portable pH 340/SET-1 WTW apparatus (WTW Wissenschaftlich-Technische Werkstätten GmbH, Weilheim, Germany). Water holding capacity was determined according to Honikel (1998). Meat colour was estimated based on the L*a*b* system (lightness, redness, yellowness; Centre Internationale de l'Eclairage, 1976) using a Konica Minolta CM-2600d spectrophotometer containing an integrated spectral component, a D65 illuminator and a 10° observer. For chemical analyses, dry matter was determined in 5 g samples pre-dried at 60 °C for 2 h, mixed with dry sea sand and dried at 105 °C for 6 h. Ash content was measured gravimetrically after burning the sample (2 g) in a muffle laboratory oven (LMH 11/12; LAC Rajhrad, Czech Republic) at 550 °C for 8 h. Protein (Kjeldahl nitrogen×6.25) and collagen content was determined according to the AOAC methods (2000 and 1996, respectively). Myoglobin concentration was measured as described by Hornsey (1956). Intramuscular fat (IMF) was determined gravimetrically after spiking 50 g of the MQF sample with 5 ml of the internal standard solution (2.5 mg of C15:0/ml isooctane; Supelco) and extraction with petrol ether in a

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Soxhlet extractor for 6 h. Physical and chemical characteristics were measured in each sample in duplicate.

A linear mixed effects model (*Hopkins et al.*, 2007b) was used for statistical evaluation. Breed was used as the fixed term and the age of lambs as the random term in the calculations. When a significant effect of breed on a particular trait was found, the post-hoc Duncan's test was used for testing the particular differences between the predicted means. Correlation analysis was used for evaluation of relationships between traits. All statistical analyses were performed using software GenStat Release, version 13.1 (VSN International Ltd., 2010).

## Results and discussion

The genotype had no significant effect on average daily gain (ADG) of the lambs (*Table 1*), which is in line with *Zapletal et al.* (2010) and *Esenbuga et al*. (2009). On the other hand, *Fogarty et al.* (2000) and *Hopkins et al.* (2007a) reported significant differences in growth rates between lamb genotypes. However, the ADGs in our experiment were lower compared to data published by *Burke et al*. (2003) and *Christodoulou et al*. (2007). In our opinion the relatively low ADGs of lambs in our experiment were mainly affected by the extensive feeding of the lambs. Genotype also did not affect dressing percentage (DP) which is in accordance with findings reported by *Kuchtík et al*. (2012) and *Gutierrez et al.* (2005). Concurrently, the DP of all genotypes in our experiment were higher in comparison with the data by *Rodrigues et al*. (2006), who also evaluated Suffolk lambs.

***Table 1*: Growth and basic carcass traits of lambs of the three breeds**

| Trait | Breed (mean±SEM) | | |
|---|---|---|---|
| | Zwartbles | Suffolk | Oxford Down |
| Birth weight (kg) | $3.73^{A}$±0.05 | $4.06^{B}$±0.07 | $3.90^{A}$±0.06 |
| Live weight at slaughter (kg) | $38.1^{A}$±0.9 | $38.8^{A}$±1.2 | $36.3^{A}$±1.3 |
| Slaughter age (days) | $207^{B}$±0.7 | $200^{A}$±1.1 | $209^{B}$±0.8 |
| Average daily gain (g) | $167^{A}$±4.3 | $170^{A}$±5.8 | $158^{A}$±5.9 |
| Cold carcass weight (kg) | $18.8^{A}$±0.6 | $18.7^{A}$±0.8 | $18.0^{A}$±0.9 |
| Dressing percentage (%) | $49.2^{A}$±0.8 | $48.1^{A}$±1.0 | $49.5^{A}$±1.0 |
| Kidney weight (g) | $130^{B}$±7.4 | $116^{AB}$±9.9 | $103^{A}$±10.1 |
| Kidney fat weight (g) | $167^{AB}$±23.2 | $135^{A}$±7.8 | $195^{B}$±28.7 |
| Conformation score | $2.7^{A}$±0.12 | $3.8^{B}$±0.09 | $3.5^{B}$±0.11 |
| Fatness score | $2.2^{A}$±0.10 | $2.2^{A}$±0.11 | $2.7^{B}$±0.28 |

A, B — means with different superscripts in lines differ at P $\leq$ 0.05.

The genotype significantly affected both the kidney weight (KW) and the weight of kidney fat (WKF), when the highest KW was foud in Zwartbles (ZW) and the the highest WKF in Oxford Down (OD). However the WKF in all genotypes were comparable to the data published by Archimede et al. (2008) in Ovin Martinik lambs. The best conformation score (CS) was found in Suffolk lambs (SF) and in these lambs was also found relatively low fatness score (FS). On the other hand the worst CS was found in ZW, nevertheless in these lambs was also determined relatively low FS that was comparable with SF lambs. In ZW was also found the significantly lowest content of IMF (*Table 2*). On the other hand the highest content of IMF was found in SF, which was not expected because in the same lambs were found relatively low FS. However this contradiction can be explained by the fact that the measurement of IMF is an exact laboratory method, contrary to fatness score that is evaluated only subjectively.

***Table 2*: Physical and chemical quality characteristics of the lamb meat[a] of the three breeds**

| Trait | Breed (mean±SEM) | | |
|---|---|---|---|
| | Zwartbles | Suffolk | Oxford Down |
| Dry matter (g $kg^{-1}$) | $22.0^{A}$±0.20 | $23.2^{B}$±0.26 | $22.8^{B}$±0.27 |
| Ash (g $kg^{-1}$) | $1.12^{B}$±0.01 | $1.08^{A}$±0.01 | $1.08^{A}$±0.01 |
| Protein (g $kg^{-1}$) | $19.0^{A}$±0.13 | $18.9^{A}$±0.18 | $18.9^{A}$±0.17 |
| Collagen (g $kg^{-1}$) | $2.35^{A}$±0.23 | $2.46^{AB}$±0.30 | $2.94^{B}$±0.31 |
| Myoglobin (g $kg^{-1}$) | $2.27^{A}$±0.08 | $2.34^{AB}$±0.36 | $2.49^{B}$±0.37 |
| IMF (g $kg^{-1}$) | $1.74^{A}$±0.27 | $3.07^{B}$±0.36 | $2.79^{B}$±0.37 |
| $pH_{24}$ | $5.68^{A}$±0.01 | $5.69^{A}$±0.02 | $5.74^{A}$±0.02 |
| WHC (%) | $18.8^{A}$±0.75 | $17.9^{A}$±1.01 | $17.0^{A}$±1.03 |
| Lightness index (L*) | $48.4^{A}$±0.72 | $47.2^{A}$±0.97 | $50.1^{A}$±0.99 |
| Redness index (a*) | $8.49^{A}$±0.40 | $8.60^{A}$±0.54 | $9.23^{A}$±0.56 |
| Yellowness index (b*) | $12.5^{A}$±0.27 | $12.1^{A}$±0.36 | $13.4^{A}$±0.3 |

A, B — means with different superscripts in lines differ at $P \leq 0.05$; [a] Muscullus quadriceps femoris, IMF = intramuscular fat, WHC = water-holding capacity,

The genotype had a significant effect on dry matter content which is in agreement with *Juarez et al.* (2009). The same authors also reported a significant effect of genotype on contents of protein and ash. However in our experiment the genotype had a significant effect only on ash content. Nevertheless the contents of both these chemical characteristics in our experiment were comparable with data published by *Esenbuga et al*. (2009).

Collagen content plays a role in the overal tenderness of muscle and according to *Esenbuga et al*. (2009) its content is not affected by genotype. Nevertheless in our experiment its content was significantly affected by this factor when the highest content was found in OD. The significant effect of breed on myoglobin concentration in lamb meat agrees with the results of *Juárez et al*. (2009) and *Gardner et al*. (2007). According to *Gardner et al*. (2007), strong correlations between myoglobin concentration (which increases with age) and lightness and redness highlight the importance of age at slaughter in terms of colour acceptability for consumers.

According to *Juarez et al*. (2009) the genotype had a significant effect on meat colour of lambs slaughtered in the same weight. Nevrtheless in our experiment the genotype had no significant effect on lightness index, redness index and yellowness index but meat from OD was insignicantly lighter, redder and yellower in comparison with all other genotypes. The genotype also had no significant effect on $pH_{24}$ and water-holding capacity (WHC). The $pH_{24}$ values ranged from 5.68 to 5.74 and according to *Tejeda et al.* (2008) these values are in the normal range for lamb meat. However, in our experiment it was also found that the lower $pH_{24}$ the higher WHC which is in line with *Diaz et al.* (2002). On the other hand *Caneque et al*. (2001) state that $pH_{24}$ does not affect WHC.

## Conclusions

The genotype had a significant effect on weights of kidney and kidney fat. The genotype had also significant effect on both conformation score and fatness score. With regard to physical and chemical quality characteristics of lamb meat, the genotype had a significant effect on contents of dry matter, ash, collagen, myoglobin and intramuscular fat. On the other had the genotype had no significant effect on $pH_{24}$, water-holding capacity, lightness index, redness index and yellowness index. The genotype also had no significant effect on daily gain and dressing percentage. In general, it can be stated that the highest daily gain and the best both conformation and fatness score were found in Suffolk lambs. However in Zwartbles lambs, which is dual-purpose breed, relatively high dressing percentage, low fatness score, relatively high contents of ash and protein and low content of intramuscular fat were found

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10.17205/SZIE.AWETH.2019.2.058