IN VIVO ASSESSMENT OF GROWTH TRAITS AND MEAT PRODUCTION IN CHAROLLAIS AND KENT LAMBS*

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The objective of this study was to determine the effect of lambing year, month of lambing, sex of lamb, sire effect, dam’s age effect, and effect of litter size on the indicators of meat production of Charollais and Kent breeds. The evaluation was conducted between the years 2009–2011, when 591 of Charollais and Kent lambs were monitored. The lambing year had a significant effect only on birth weight. Similarly, the month of lambing was manifested in significant birth weight differences. We observed a higher growth intensity in lambs born in spring (March, April). These ram-lambs had greater birth weight, live weight at 100 days of age, average daily gains from birth to 100 days of age, and musculus longissimus lumborum et thoracis (MLLT) depth compared with ewe-lambs. Similarly, a greater fat thickness was measured in ram-lambs. Comparing individual sires, the most significant differences were obvious in birth weight, in MLLT depth, and in fat thickness. On the other hand, the highest growth abilities and the lowest fat thickness were observed in sheep at the age of 4 years. Comparing litter size, the highest attributes were achieved in singles rather than in twins and triplets.

INTRODUCTION

The Charollais breed is classified among meat type-sheep. Horák et al. (2007) noted that from the viewpoint of meat utility, it belongs to the best breeds overall. This is confirmed by the data of Performance Recording: live weight at 100 days of age 30.4 kg and daily gain from birth to 100 days of age 270 g (Bucek et al., 2011). Horák et al. (2007) noted very good reproduction parameters, and Bucek et al. (2011) added the accurate fertility value of 162.3% in the pure-bred population. Horák et al. (2007) defined the Kent breed as resistant, undemanding, combined (wool-meat), exhibiting good pasture abilities. Bucek et al. (2011) specified the growth abilities – 29.6 kg in live weight at 100 days of age and 264 g in daily gain from birth to 100 days of age, while fertility in the pure-blood population amounted to 153.6%.

Although the average consumption of mutton in the Czech Republic reaches 0.25 kg per capita (Roubalová, 2011), which is deeply below the average of the EU, meat utility determines the economy in sheep breeding. This is reflected in the composition of sheep population when almost 90% of sheep in the Czech Republic belong to the combined- and meat-type. Pindák, Milerski (2007) state that loin, lower back, and rump belong to the most valuable slaughter parts of the carcass (influencing the meatiness of the carcass as a whole).

Meat parameters and meat quality are annually recorded by the Association of Sheep and Goat Breeders. These indicators are influenced by many other effects, as demonstrated by Navajas et al. (2008), Bünge et al. (2009), Kuchtík et al. (2010, 2011), Ptáček et al. (2011), and Štolc et al. (2011). In the present study we investigated the effects of year and month of lambing, gender of lamb, bloodline of Sire, age of ewe and litter size in the meat-type sheep Charollais and combined-type (wool-meat) sheep Kent.

Hypothesis: Meat production parameters in lambs are influenced by the following internal and external factors: race, sire of lamb, age of ewe, sex of lamb, litter size, year and month of lambing.

MATERIAL AND METHODS

The farm selected for the study is situated at the foothills, ca. 600 m above sea level. The farm manages a total area of 1684 ha of agricultural farmland, and the basic stock numbers about 350 Charollais ewes, 35 Charollais rams, 200 Kent ewes, and 12 Kent rams. In this area, the average annual rainfall and temperature reports are ca. 518 mm and 7.8°C respectively. From

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May to October the sheep are kept only on pasture without the possibility of housing in sheep pens and thus the feeding ration of ewes is composed of pasture only. From November to April the sheep are housed in sheep pens, and the feeding ration is composed of hay (*ad libitum*) and haylage (3.0 kg/day per ewe). The feeding ration of lambs consists of mother’s milk, from the 1st week of age supplemented with concentrates (called early weaning of lambs in a quantity of 300 g per lamb), and of hay (*ad libitum*) offered via lamb creep.

The monitoring was performed as a field test within a pure-bred population of Charollais and Kent sheep. Data of the Performance Recording and records from the selected farm from 2009–2011 were kept, and 591 lambs of both breeds (460 Charollais and 131 Kent) were monitored in all. Lambs were born from the mating of nine Charollais and two Kent rams (eleven different bloodlines).

A total of 111 lambs were born to sheep at the age of 1–2 years (mainly primiparous), 123 lambs to ewes at the age of 3 years, 135 lambs to ewes at the age of 4 years, 102 lambs to ewes at the age of 5 years, and 120 lambs to ewes at the age of 6 years and more (6+). Finally we grouped one- and two-year-old sheep and six and more year-old ewes due to a low number of sheep at those age categories.

Lambs’ birth weight (BW) and live weight at 100 days of age (LW 100) – weighed on scales for ad libitum) offered via 100 days of age (DG 100) was calculated. Subsequently the daily gain from birth to 100 days of age (MLLT muscle depth, fat thickness) was recalculated by linear interpolation on an average of the 6th month of age. From November to April the sheep are housed without the possibility of housing in sheep pens and only. From November to April the sheep are housed without the possibility of housing in sheep pens and only. From November to April the sheep are housed without the possibility of housing in sheep pens and only.

Table 1. Effects of year of lambing, month of lambing, and sex of lambs on selected attributes

<table>
<thead>
<tr>
<th>Year of lambing</th>
<th>BW (kg)</th>
<th>LW 100 (kg)</th>
<th>DG 100 (g)</th>
<th>MLLT (mm)</th>
<th>Fatness (mm)</th>
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<tbody>
<tr>
<td>2009 (n = 193)</td>
<td>3.12 ± 0.085&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.51 ± 2.090</td>
<td>265.59 ± 24.675</td>
<td>23.26 ± 1.515</td>
<td>3.61 ± 0.844</td>
</tr>
<tr>
<td>2010 (n = 195)</td>
<td>3.08 ± 0.073&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.06 ± 1.948</td>
<td>222.64 ± 22.316</td>
<td>23.04 ± 1.340</td>
<td>3.03 ± 0.746</td>
</tr>
<tr>
<td>2011 (n = 203)</td>
<td>2.94 ± 0.075&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.17 ± 2.018</td>
<td>219.59 ± 23.563</td>
<td>22.91 ± 1.447</td>
<td>2.91 ± 0.806</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Season (month) of lambing</th>
<th>BW (kg)</th>
<th>LW 100 (kg)</th>
<th>DG 100 (g)</th>
<th>MLLT (mm)</th>
<th>Fatness (mm)</th>
</tr>
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<tbody>
<tr>
<td>January (n = 172)</td>
<td>3.08 ± 0.069</td>
<td>25.24 ± 2.399</td>
<td>194.88 ± 28.844</td>
<td>21.05 ± 1.742</td>
<td>2.70 ± 0.970</td>
</tr>
<tr>
<td>February (n = 58)</td>
<td>3.20 ± 0.097</td>
<td>26.68 ± 2.364</td>
<td>208.81 ± 27.800</td>
<td>22.00 ± 1.670</td>
<td>3.02 ± 0.930</td>
</tr>
<tr>
<td>March (n = 204)</td>
<td>3.17 ± 0.057&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.85 ± 1.338</td>
<td>261.57 ± 15.603</td>
<td>24.48 ± 0.946</td>
<td>3.50 ± 0.527</td>
</tr>
<tr>
<td>April (n = 157)</td>
<td>2.99 ± 0.084&lt;sup&gt;a&lt;/sup&gt;</td>
<td>29.22 ± 1.473</td>
<td>278.52 ± 17.306</td>
<td>24.74 ± 1.046</td>
<td>3.52 ± 0.583</td>
</tr>
</tbody>
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<thead>
<tr>
<th>Sex of lambs</th>
<th>BW (kg)</th>
<th>LW 100 (kg)</th>
<th>DG 100 (g)</th>
<th>MLLT (mm)</th>
<th>Fatness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ram-lambs (n = 289)</td>
<td>3.16 ± 0.049&lt;sup&gt;b&lt;/sup&gt;</td>
<td>28.46 ± 0.826&lt;sup&gt;d&lt;/sup&gt;</td>
<td>247.71 ± 8.763&lt;sup&gt;b&lt;/sup&gt;</td>
<td>23.45 ± 0.528&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.23 ± 0.294</td>
</tr>
<tr>
<td>Ewe-lambs (n = 302)</td>
<td>3.06 ± 0.050&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26.03 ± 0.890&lt;sup&gt;a&lt;/sup&gt;</td>
<td>224.17 ± 9.501&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.69 ± 0.577&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.14 ± 0.321</td>
</tr>
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**Y**<sub>ijklmnop</sub> = **µ** + **Ai** + **Bj** + **Ck** + **Dl** + **Fm** + **Go** + **eijklmop**

where:

- **Y**<sub>ijklmnop</sub> = value of dependent variable (birth weight, weight at 100 days of age, daily gain from birth to 100 days of age, MLLT depth, fat thickness)
- **µ** = general value of dependent variable
- **Ai** = fixed effect of *i*<sup>th</sup>-year of lambing (*i* = 2009, 2010, 2011)
- **Bj** = fixed effect of *j*<sup>th</sup>-month of lambing (*j* = January, February, March, April)
- **Ck** = fixed effect of *k*<sup>th</sup>-lamb gender (*k* = ram-lambs, ewe-lambs)
- **Dl** = fixed effect of *l*<sup>th</sup>-bloodline of sire (*l* = Charis, Chiron, Chotik, Chinin, Choral)
- **Fm** = fixed effect of *m*<sup>th</sup>-age of ewe (*m* = 1<sup>st</sup> and 2<sup>nd</sup> years of age, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup> years of age)
- **G**<sub>o</sub> = fixed effect of *o*<sup>th</sup>-litter size (*o* = singles, twins, triplets)
- **eijklmop** = residual error
Differences among the variables were evaluated at the levels of statistical significance of $P < 0.05$ and $P < 0.01$.

RESULTS

Effect of lambing year

The year of lambing had a significant effect only on BW ($P < 0.05$; 0.01), as presented in Table 1. The highest BW was recorded in 2009, when differences in this parameter fluctuated between 0.04 kg ($P < 0.05$) and 0.18 kg ($P < 0.01$). No other statistically significant differences were found in all the indicators evaluated, although we observed differences in average values in the years 2009–2011 in the meat parameters: LW 100: 0.11–0.45 kg; DG 100: 3.05–46.00 g; MLLT: 0.13–0.35 mm, and fat thickness: 0.12–0.70 mm.

Effect of lambing month

Lambs on the selected farm were born from January to April, as presented in Table 1. The first two months represent the winter lambing system, and the second two months the spring lambing system. We observed that statistically significant differences in lambing month – and related lambing systems – were recorded in BW only, and only between March and April ($P < 0.05$), which means two spring lambing system months. Statistically significant differences in other meat parameters evaluated were not evident. Nevertheless, after more detailed analysis of the results in Table 1, we observed higher average values of other meat indicators in the months representing spring lambing compared with those representing winter lambing system ($P > 0.05$). A systematic increase in the evaluated indicators connected with later months of lambing was found. Thus, the highest values of LW 100, DG 100, and MLLT depth were obtained in April, while the lowest were found in January. This increase also applied to fat thickness. Namely, the differences in the month observed amounted to an average of 1.17–3.98 kg in LW 100, 52.76–83.64 g in DG 100, 2.48–3.69 mm in MLLT depth, and 0.48–0.82 mm in fat thickness.

According to the results presented, we can summarize that the spring lambing system is more advantageous for the growth intensity of lambs, although the results cannot be statistically confirmed at the levels of $P < 0.05$ and $P < 0.01$.

Effect of lamb’s sex

According to Table 1, the sex of the lambs influenced all meat parameters except for fat thickness. Ram-lambs had BW on the average by 0.1 kg higher than ewe-lambs ($P < 0.05$). Also, ram-lambs had LW 100 by 2.43 kg and DG 100 by 23.54 g higher on the average compared to ewe-lambs ($P < 0.01$). An interesting finding was an average lower level of back fat in ewe-lambs (–0.09 mm), although the statistical difference cannot be considered significant at $P < 0.05$ and $P < 0.01$.

Effect of sire

In accordance with the results presented in Table 2, we can observe the influence of sire effect in the stud. There were found differences among sires within the evaluated breed as well as among sires of both races.
evaluated (sires of bloodlines Charis-Chural were Charollais breed, those of bloodlines Knop-Storm were Kent breed). Statistically significant differences were apparent in BW, MLLT depth, and fat thickness ($P < 0.05$–0.01). The lowest BW was recorded in the Kent sire Knop bloodline. The differences in these parameters were statistically more significant in all the other bloodlines evaluated (thus in both breeds evaluated). The differences ranged from 0.32 to 0.82 kg ($P < 0.05$–0.01). Statistically higher differences in the MLLT depth were found in the Chlor bloodline compared with Charis sire (+ 2.4 mm; $P < 0.05$), Chinin sire (+ 2.91 mm; $P < 0.05$), Knop sire (+ 6.98 mm; $P < 0.05$), and Storm sire (+ 3.51 mm; $P < 0.01$). The most distinct differences were recorded in the two last-mentioned sires (both are representatives of the Kent breed). MLLT depth is an important indicator of the overall meatiness of a lamb. This factor allows us comparison of the key meat production between both breeds. Despite lower MLLT depth ($P < 0.05–0.01$) compared with the Chlor bloodline, the Kent bloodline showed lower average values in MLLT depth compared with other Charollais sires (6.74–0.60 mm; $P > 0.05$). Although statistically significant differences in fat thickness were observed at $P < 0.05$ and 0.01, they were not recorded between the breeds. Rather statistically significant differences ($P < 0.05–0.01$) were apparent just among Charollais sires.

**Dam’s age effect**

The effects of dam’s age and litter size on selected meat production parameters are presented in Table 3. The age of the dam had a significant effect ($P < 0.05–0.01$) on all monitored indicators except for fat thickness. The lowest values were achieved in groups of 1–2-year-old and 6+ year-old sheep. The first group, 1–2-year-olds, was composed mainly of primiparous sheep, because of the mating system on the selected farm. Ewe-lambs are not introduced to the ram in the first year of life, and thus the first lambing comes in the second year of age.

Culmination in meat production was evident in 4–5 year-old sheep, where, compared with other sheep groups, definitely the highest LW 100 and DG 100 ($P < 0.05–0.01$) were observed. Precisely at the age of 4 years the ewes exceeded the selected parameters (0.41–2.56 kg in LW 100, 3.87–24.38 g in DG 100, and 1.00–2.45 mm in MLLT depth). Along with with the highest growth indicators in ewes at the age of 4 years, we found the lowest fat thickness overall (0.06–0.41 mm; $P > 0.05$). These results made this group the most appropriate one for lamb production, for example in insemination or embryotransfer performed in practice. Ewes at the age of 5 years also showed excellent meat parameters as mentioned before. These sheep exceeded the groups of 1–2 year, 3-year, and 6 or more-year-old sheep with more than 1.59–2.15 kg in LW 100, 13.97–20.51 g in DG 100, and 0.25–1.45 mm in MLLT depth. It is necessary to mention that in this group of ewes exhibited the highest fat thickness (+ 0.04–0.41 mm). Group 6+ was found to be the least suitable group of ewes with the lowest growth intensity (LW 100, DG 100, and MLLT depth) and fat thickness.

From the viewpoint of commercial studs it is acceptable to keep sheep above the 5th year of age. In the case of pedigree studs – the primary objective is to produce pedigree rams and ewe-lambs – we can definitely recommend culling sheep with regard to their age as presented in Table 3.

**Effect of litter size**

The effect of litter size influences all meat indicators as presented in Table 3 and thus it proved to

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**Table 3. Effects of age of dams and litter size on selected attributes**

<table>
<thead>
<tr>
<th>Age of sheep</th>
<th>BW (kg)</th>
<th>LW 100 (kg)</th>
<th>DG 100 (g)</th>
<th>MLLT (mm)</th>
<th>Fatness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LSM ± SEM</td>
<td>LSM ± SEM</td>
<td>LSM ± SEM</td>
<td>LSM ± SEM</td>
<td></td>
</tr>
<tr>
<td>A. 1st and 2nd year of age (n = 111)</td>
<td>2.78 ± 0.072&lt;sup&gt;BCDE&lt;/sup&gt;</td>
<td>26.21 ± 1.033&lt;sup&gt;C&lt;/sup&gt;d</td>
<td>23.08 ± 10.492</td>
<td>22.59 ± 0.647&lt;sup&gt;C&lt;/sup&gt;c</td>
<td>3.07 ± 0.361</td>
</tr>
<tr>
<td>B. 3rd year of age (n = 123)</td>
<td>3.11 ± 0.063&lt;sup&gt;A&lt;/sup&gt;</td>
<td>26.75 ± 1.058&lt;sup&gt;C&lt;/sup&gt;c</td>
<td>23.08 ± 11.051</td>
<td>23.11 ± 0.673&lt;sup&gt;ce&lt;/sup&gt;</td>
<td>3.06 ± 0.375</td>
</tr>
<tr>
<td>C. 4th year of age (n = 135)</td>
<td>3.23 ± 0.067&lt;sup&gt;A&lt;/sup&gt;</td>
<td>28.75 ± 0.981&lt;sup&gt;AB&lt;/sup&gt;e</td>
<td>248.74 ± 10.341&lt;sup&gt;B&lt;/sup&gt;f</td>
<td>24.36 ± 0.623&lt;sup&gt;AB&lt;/sup&gt;e</td>
<td>3.00 ± 0.347</td>
</tr>
<tr>
<td>D. 5th year of age (n = 102)</td>
<td>3.21 ± 0.064&lt;sup&gt;A&lt;/sup&gt;</td>
<td>28.34 ± 0.983&lt;sup&gt;AB&lt;/sup&gt;e</td>
<td>244.87 ± 10.379&lt;sup&gt;AB&lt;/sup&gt;e</td>
<td>23.36 ± 0.631</td>
<td>3.41 ± 0.351</td>
</tr>
<tr>
<td>E. 6+ years of age (n = 120)</td>
<td>3.22 ± 0.066&lt;sup&gt;A&lt;/sup&gt;</td>
<td>26.19 ± 1.036&lt;sup&gt;CD&lt;/sup&gt;d</td>
<td>224.36 ± 10.746&lt;sup&gt;CD&lt;/sup&gt;d</td>
<td>21.91 ± 0.655&lt;sup&gt;BC&lt;/sup&gt;c</td>
<td>3.37 ± 0.365</td>
</tr>
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</table>

| Litter size | | | |
|--------------|---------|-------------|------------|-----------|--------------|
|              | LSM ± SEM | LSM ± SEM | LSM ± SEM |
| A. singles (n = 179) | 3.68 ± 0.051<sup>BC</sup> | 31.70 ± 0.854<sup>BC</sup>c | 274.17 ± 9.121<sup>BC</sup>e | 26.00 ± 0.551<sup>BC</sup>c | 3.84 ± 0.307<sup>BC</sup>e |
| B. twins (n = 377) | 3.07 ± 0.038<sup>AC</sup> | 26.80 ± 0.719<sup>AC</sup> | 231.30 ± 7.937<sup>AC</sup>c | 22.49 ± 0.478<sup>AC</sup> | 3.13 ± 0.266<sup>A</sup> |
| C. triplets (n = 35) | 2.58 ± 0.104<sup>AB</sup> | 23.24 ± 1.539<sup>AB</sup> | 202.36 ± 15.504<sup>AB</sup> | 20.71 ± 0.947<sup>AB</sup> | 2.58 ± 0.528<sup>A</sup> |

a, b, c, d, e – $P < 0.05$; A, B, C, D, E – $P < 0.01$; different letters confirm statistical significance. Key: BW – birth weight; LW 100 – live weight at 100 days of age; DG 100 – daily gain from birth to 100 days of age; MLLT – the MLLT muscle depth; fatness – the fat thickness.
be very significant. The highest values were clearly achieved by singles \((P < 0.01)\). BW of singles was by 0.61 kg higher compared with twins \((P < 0.01)\) and even by 1.1 kg higher compared with triplets \((P < 0.01)\). Concerning the other evaluated parameters, growth abilities of singles exceeded 8.46 kg in LW 100, 71.81 g in DG 100, and 5.29 mm in MLLT depth. All these results were obtained comparing singles with triplets \((P < 0.01)\). Along with the highest growth abilities, singles also showed the highest fatness; differences between singles and twins or triplets in fat thickness amounted to 0.71 mm \((P < 0.01)\) or 1.26 mm \((P < 0.05)\). While high statistical differences among lambs coming from twins and singles were demonstrated at \(P < 0.01\), differences among twins and triplets at the same level of significance appeared only in BW. Other growth intensity indicators \(\text{LW 100, DG 100, and MLLT depth}\) were demonstrated at \(P < 0.05\). Values in the twins compared to those in the triplets were by 3.56 kg in LW 100, 28.94 g in DG, and by 1.78 mm in MLLT depth higher. Statistically significant differences among lambs coming from twins and triplets did not appear, although in general fat thickness in triplets was by 0.71 mm lower. Concerning litter size, interestingly only 35 lambs were born as triplets, twins appeared in 63.8 and singles in 30.1%.

**DISCUSSION**

**Effect of lambing year**

The importance of the lambing year is a commonly accepted effect confirmed by a wide range of authors. This effect of lambing year on BW was obvious not only in this study, but its significance was confirmed by Mavrogenis \((1996)\), Suárez et al. \((2000)\), Ptáček et al. \((2011)\), and Stolc et al. \((2011)\). On the other hand, Momani \((1995)\) considered the effect of year on BW nonsignificant.

Of the other meat utility indicators evaluated, no statistically significant differences were obvious \((P < 0.05\) and 0.01) for lambs' rearing. We suppose that one of the key factors affecting the growth intensity of lambs is food ration in the particular systems of lambing.

**Effect of lambing month**

Month of lambing did not have a significant effect on all the indicators evaluated. Nevertheless, there are many studies confirming the significance of this effect. Yılmaz et al. \((2007)\) stated that lambs born in winter had higher BW \((P < 0.01)\) than lambs born in spring. In our study the value of BW in particular months notably varied, without any trend. However, some trends in the results \((P > 0.05)\) were apparent in LW 100, DG 100, and MLLT depth. In addition, in the spring lambing systems \((March and April)\) the highest average values were attained. These results confirm those of Yılmaz et al. \((2007)\), Kuchtik et al. \((2010)\), and Ptáček et al. \((2011)\).

In accordance with the above results, we can summarize that lambs born from the spring lambing systems showed higher growth intensity \(\text{BW, LW 100, and DG 100}\) and lower fat thickness. This evidences the suitability of the spring lambing system. The foundation of the spring lambing system was supported by Mátlová, Loučka \((2002)\), who saw its advantages in higher reproductive activity of dams and sires and a better assumption of lactation in connection with better forage quality. They also emphasized that this system of lambing uses forage for feeding ewes in lactation and lambs, which decreases the total input in lambs’ rearing. We suppose that one of the key factors affecting the growth intensity of lambs is food ration in the particular systems of lambing.

**Effect of lamb’s sex**

Horák et al. \((2007)\) mentioned that ram-lambs used to be by 7% heavier compared with ewe-lambs. According to Yılmaz et al. \((2007)\), ram-lambs had by 0.5 kg higher BW than ewe-lambs, which is in agreement with our study. Gootwine, Rozov \((2006)\) and Esmailizadeh et al. \((2011)\) also presented identical conclusions. Higher live weight at rearing \((90 \text{ days of age})\) in ram-lambs was also presented by Yılmaz et al. \((2007)\). Along with live weight, they documented higher daily gain from birth till rear-
ing, which is in agreement with our study as well. Ram-lambs also reached higher DG 100 in studies published by Ptáček et al. (2011) and Štold et al. (2011). These statements are not in full agreement with Kuchtik et al. (2010, 2011), who did not find statistically significant differences in growth abilities from the viewpoint of lambs’ sex, although from their studies it follows that ram-lambs showed higher daily gains as well.

MLLT depth together with growth abilities are important indicators reflecting the entire meatiness of lambs. According to our results, we can say that ram-lambs had higher LW 100, DG 100 (P < 0.01), and MLLT depth (P < 0.05) compared with ewe-lambs. Just the MLLT depth is in opposition to studies by Ptáček et al. (2011) and Štold et al. (2011). They found higher MLLT depth in ewe-lambs reflecting their greater meatiness (P > 0.05). Higher meatiness in ewe-lambs was also confirmed by Stanford et al. (2001) and Johnson et al. (2005). Growth allometry of individual parts of ram-lambs and ewe-lambs was mentioned by Horák et al. (2005).

Jeremiah et al. (1998) found lower fatness of ram-lambs compared with ewe-lambs. In our study, a lower fat thickness exhibited ram-lambs. This is in contrary to many other studies, among others, those by Ptáček et al. (2011) and Štold et al. (2011). In agreement with our study are, on the other hand, Stanford et al. (2001), who noticed higher fat thickness in ram-lambs at the age of 105 days.

According to this study, better nutrient conversion was evident in ram-lambs (P < 0.01). The entire fatness of the carcass increased at the same time, which is documented by greater fat thickness. Separate fattening of lambs (based on the sex of lambs) is not common in practice. Despite this claiming we summarized that ram-lambs yield 92.34 CZK higher takings per lamb compared with ewe-lambs (in average mutton purchase price 38 CZK per kg). The realization of mutton in Czech Republic is dominantly in firmly live (butcher lambs) or firmly in dead (carcasses). These systems do not include meat quality despite the fact that the SEUROP system has been methodically described in detail in the Czech Republic (Pulkrábek, 2003).

Effect of sire

We described 11 different sires of two breeds. In the Czech Republic, the Kent breed is classified as a combined-type breed, while the Charollais breed is a typical representative of a meat-type breed. Sire effect was obvious in BW which was in agreement with Esmailikadeh et al. (2011). According to their study, the breed of the sire influenced live weight at 90 days of age. Comparing sires both within and between the particular breeds, we cannot confirm the results of Esmailikadeh et al. (2011) at P < 0.01 and 0.05 in DG 100 and LW 100. On the other hand, our results are in agreement with those of Momani et al. (1995), values evaluated at 130 days of age. On the contrary, Štold et al. (2011) point out the significant influence of the sire in LW 100 and DG 100 at P < 0.05.

Differences in the MLLT depth were significant only in one sire (P < 0.05 and P < 0.01), both within and between the particular breeds. Statistically significant differences in MLLT depth were published also by Štold et al. (2011). In close connection with MLLT depth, we can mention the study by Navajas et al. (2008), who refer to sire effect in meatiness evaluation. Similarly, Štold et al. (2011) confirmed the influence of sire effect on fat thickness (P < 0.01). In our study, statistical differences were also obvious in fat thickness (P < 0.01), but the differences were found in sires within the Charollais breed. This finding is interesting in terms of the claim is of Horák et al. (2007), who pointed out the distinctive fatness in the Kent breed.

Dam’s age effect

The group of 1–2-year-old sheep along with the group of 6+ ewes belonged to the groups with the lowest meat utility of lambs (P < 0.01). The group of 1–2-year-old sheep was composed mostly of primiparas. The effect of dam’s age was confirmed by Peeters et al. (1996), who noted that lambs coming from yearlings had lower BW and growth abilities. This fact is also documented by Jakubec et al. (2001) and Esmailikadeh et al. (2011), who noted that older ewes use to have heavier lambs compared with younger sheep.

In agreement with our study were Clote et al. (2002), who reported that BW increases with the age of sheep. There was an increase in meat performance of lambs in sheep of the monitored stud until the 4th year of age. At the age of five there was a weak decrease of meat production of lambs; nevertheless, all the indicators were still higher than in the group of 1–2-year-old sheep. The influence of ewes’ age on gain from birth to 30 days of age is also affirmed by Momani et al. (1994).

Effect of litter size

Jakubec et al. (2001), Gootwine, Rozov (2006), and Horák et al. (2007) found the highest BW in singles. This is in accord with our study. Statistically very significant differences (P < 0.01) were obvious among singles and twins and singles and triplets. Depending on litter size of lambs, Horák et al. (2007) noticed that BW of twins ranged 3–3.5 kg and BW of triplets made 2–3.5 kg. According to the results published in our study, we can definitely confirm their claim, because BW of lambs was exactly in the range published by Horák et al. (2007). This opinion
is also in agreement with Gootwine (2005), who claimed that BW decreases with increasing litter size. As a possible explanation of this fact Gootwine (2005) noted that with increasing litter size each fetus gets a lower supply of nutrients and lower metabolite lysis.

Higher LW 100 in singles was also documented by Kuchtík et al. (2010). On the other hand, statistically significant differences among twins and multiple litters were not shown. Higher LW 100 in singles at \( P < 0.01 \) was documented in our study, while differences among twins and triplets were shown at \( P < 0.05 \). Identical results among singles and twins were also presented by Suárez et al. (2000).

An explanation of the differences in growth abilities of lambs coming from various litter sizes Snowder, Glimp (1991) saw in their different opportunities of milk suckling. In singles milk consumption is almost equal to \textit{ad libitum}, while in twins or triplets milk production of sheep is influenced by the rate of milk production as a limiting factor.

CONCLUSION

In the present study the influence of year of lambing, month of lambing, sex of lamb, sire effect, effect of age of dam and litter size on selected meat production parameters were evaluated. The evaluation took place within the years 2009–2011 when 460 Charollais and 131 Kent lambs were observed. Statistically significant differences were obvious in all the evaluated parameters, although statistical differences in the year of lambing and month of lambing were recorded only in BW. More important was the comparison of the sex of lambs. Ram-lambs were born more frequently and had higher growth intensity (LW 100, DG 100, MLLT depth) compared with ewe-lambs \((P < 0.05 \text{ and } 0.01)\). Also, fat thickness was greater in ram-lambs \((P < 0.05)\). Sire effect influenced BW, MLLT depth, and fat thickness \((P < 0.05 \text{ and } 0.01)\). In evaluation of sire effect we also compared two different sheep breeds (Charollais and Kent). Sheep at the age of 1 and 2 years together with the group of 6+ ewes showed the lowest indicators of all evaluated parameters. The highest meat performance was observed in sheep at the age of 4 and 5 years. We can state a definite conclusion concerning the effect of litter size. Singles showed the highest values in all the evaluated parameters, compared with twins as well as triplets \((P < 0.01)\). Similarly, statistically significant higher differences were observed also between twins and triplets. The study comparing two breeds under the same breeding conditions brought findings concerning qualitative and quantitative meat production parameters. Hopefully the gained knowledge will contribute to stud management (e.g. sheep lambing system, sheep culling).

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