Short communication

Carcass traits and meat quality differences between a traditional and an intensive production model of market lambs in Brazil: Preliminary investigation

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A B S T R A C T

The objective of this study was to determine the differences of carcass traits and meat quality of market lambs between a traditional and an intensive production model. Eighty lambs were obtained from four commercial farms. At the Traditional model 20 lambs were Dorper × Santa Inês and 20 Ile de France. Farms from intensive model provided 20 Texel lambs and 20 Dorper × Santa Inês lambs. Animals from intensive model had access to creep feeding until weaning and were fed with a total mixed ration with 90% of concentrate at the finishing. The intensive model provided higher loin eye area and fat thickness, and lower shear force of the loin (\(P<0.0001\)). The Traditional model presented higher rate of polyunsaturated fatty acids (\(P<0.01\)) and lower \(\delta 6:2/\delta 6:3\) rate (\(P<0.0001\)). The loin of the animals from the intensive model presented more intense aroma and taste and higher juiciness and chewiness (\(P<0.05\)). The intensive model produced carcasses with better conformation and fatness and soft meat with better color, taste and texture.

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1. Introduction

Sheepmeat production is considered an activity with great growth potential in Brazil. Data from FAO (2013) point out that the country has approximately 17.7 million sheep, what represents a growth of 20% in a period of ten years and a proof of the importance of the activity for the national agribusiness. However, the sectors of the productive chain must search for a higher integration to reach the consolidation of the activity, seeking the economic efficiency for the breeder, stability of the production scale and certificate of quality of the meat products offered to the consumers.

The agricultural production system of the State of São Paulo (southeast region) is made up by 77.7% of farms with less than 50 ha.

The sheep herd has 507,694 heads, made up by dual-purpose and specialized breeds for meat production in commercial herds and breeders. The size of the farms and the high prices of the lands for agricultural purposes require the adoption of intensive practices of management and production of the animals, aiming to increase the productivity.

Our objective was to evaluate if the technical criteria related to the production system, slaughter and carcass traits obtained by an intensive model of lamb meat production, called Cordeiro Paulista, promote the production of quality carcass and meat.

2. Material and methods

Animal procedures were not reviewed and approved by the Universidade Federal da Grande Dourados (UFGD) and Universidade Estadual Paulista (UNESP) Animal Care and Use Committee because this experiment did not involve animals originating from or under the control of UFGD and UNESP.
The experiment was carried out in the cities of Araçatuba (21°12′32″S, 50°25′58″O) and São Manuel (22°43′52″S, 48°34′14″O), in the State of São Paulo (southeast region), Brazil. Four farms were used, where two were considered as Traditional production model and the other two employed the Cordeiro Paulista intensive production model. The description of the production models is shown in Table 1. Twenty entire male lambs from each farm were randomly chosen at the moment of trading to slaughter, resulting in 40 lambs from Traditional model and 40 from Cordeiro Paulista to be evaluated. Generally, for market lambs the slaughter weight ranges between 30 and 35 kg, but each farm decided the moment of trade. At the slaughter all lambs showed milk teeth.

Within Traditional production model, both farms maintained the lambs with their moms until the weaning, without access to creep feeding. One farm raised Dorper × Santa Inês lambs which were finished under Brachiaria spp. pasture. The other farm raised Ile de France lambs finished under Cynodon spp. pasture. The average age of weaning and slaughter was 73.6 ± 5.9 and 179.5 ± 27.4 days, respectively. The two farms produced their lambs from the breeding season of 2012. The average birth and weaning weight for Traditional model were 4.7 ± 0.8 and 22.4 ± 2.9 kg, respectively.

Each farm of Cordeiro Paulista model followed the technical criteria of production presented in Table 1. One farm raised Texel lambs and the other Dorper × Santa Inês lambs. At both farms for the creep feeding and feedlot the lambs received commercial diets ad libitum. The concentrate used in the creep feeding and feedlot the lambs received commercial diets ad libitum. The concentrate used in the creep feeding and feedlot the lambs received commercial diets ad libitum. The concentrate used in the creep feeding and feedlot the lambs received commercial diets ad libitum. The concentrate used in the creep feeding and feedlot the lambs received commercial diets ad libitum. The concentrate used in the creep feeding and feedlot the lambs received commercial diets ad libitum. The concentrate used in the creep feeding and feedlot the lambs received commercial diets ad libitum. The concentrate used in the creep feeding and feedlot the lambs received commercial diets ad libitum. 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3. Results

The animals from the Cordeiro Paulista model presented increased BW, BC, ULEA, ULEA:BW, USFT, HCW, and HCY (Table 2). For the Traditional model, 47.5% of the carcasses presented reasonable conformation class (O) and half of them presented fatness class 2 (slight). By combining the conformation and fatness classes, 32.5% of the carcasses of the Traditional model were classified as O2. The Cordeiro Paulista model presented 46.51% of the carcasses with good conformation (R) and 37.21% with fatness class 4 (abundant), resulting in 18.6% of the carcasses classified as R3 (Table 3).

The production model influenced the instrumental traits and the subjective colour of the loin (Table 4). The lambs produced in the Cordeiro Paulista model presented increased L*, a*, b*, and WHC and decreased subjective colour and SF. There was effect of the production model on the undecanoic (C11:0), pentadecanoic (C15:0) and heptadecanoic (C17:0) saturated fatty acids and pentadecenoic (C15:1), heptadecenoic (C17:1), elaidic (C18:1o9t), linolealidic (C18:2o6t), linolenic (C18:3o3), gamma linolenic (C18:3o6), C20:3o3 and C20:3o6 unsaturated fatty acids of the loin, with increased values for the Traditional model (Table 5).

The Cordeiro Paulista model presented increased ratio of oleic (C18:1o9c) and C22:2.

There was no difference between the ratio and relation of unsaturated and saturated fatty acids between the production models (Table 5). The Traditional model presented increased total ratio of polyunsaturated fatty acids and ω3, while the Cordeiro Paulista model obtained increased ratio of monounsaturated fatty acids and C18:1o9. These differences resulted in better ω6:ω3 ratio for the Traditional model (2.44 vs 7.22).

The sensorial characteristics of aroma intensity, flavor, juiciness and chewiness were influenced by the production model (Table 6). The loin of the animals produced in the Cordeiro Paulista model presented more intense aroma and flavor, typical of sheep meat, in comparison to the Traditional model. Juiciness and chewiness had increased scores for samples of the Cordeiro Paulista model.

4. Discussion

Each sheep breed has advantages and disadvantages across traits related to meat production, and no single breed excels for all growth, carcass, and quality traits. Terminal breeds have greater growth rate, larger loin eye area, and leaner carcasses. Prolific breeds have more tender meat than terminal breeds. General purpose hair and wool breeds show intermediate values for growth, carcass, and quality traits to terminal and prolific breeds (Shackelford et al., 2012). The most outstanding difference between the breeds on the quality traits, whether the carcass or meat, is the

### Table 2
Effect of the production model on in vivo and carcass traits.

<table>
<thead>
<tr>
<th>Item</th>
<th>Production model</th>
<th>Traditional</th>
<th>Cordeiro Paulista</th>
<th>SEM</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW, kg</td>
<td>32.6</td>
<td>37.1</td>
<td>0.54</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>BC</td>
<td>2.84</td>
<td>3.58</td>
<td>0.06</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>ULEA, cm²</td>
<td>12.74</td>
<td>17.46</td>
<td>0.45</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>ULEA:BW, cm²/kg</td>
<td>0.39</td>
<td>0.47</td>
<td>0.01</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>USFT, mm</td>
<td>1.74</td>
<td>2.35</td>
<td>0.05</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>HCW, kg</td>
<td>13.9</td>
<td>18.1</td>
<td>0.31</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>HCY, %</td>
<td>42.8</td>
<td>48.5</td>
<td>0.33</td>
<td>**</td>
<td></td>
</tr>
</tbody>
</table>

**P < 0.05, ns = not significant.

a Body weight (BW); body condition (BC); ultrasound loin eye area (ULEA); ultrasonic subcutaneous fat thickness (USFT); hot carcass weight (HCW); hot carcass yield (HCY).

b Standard error of the mean (SEM).

P < 0.01.

P < 0.0001.
fat partition among depots and their distribution through the animal’s body. This is a result of differences in adult size and precocity (Sañudo et al., 1997), which are reflected in the most tender meat of prolific breeds, for example.

The effect of slaughter weight on carcass and meat quality traits is explained by the phenomenon of growth and development of animals. Hammond (1940) defines growth as increase in mass, or weight, until the animal reaches the adult size, and development as the changing of forms and body conformation. Butterfield (1988) describes that the major change that occurs in the development of carcass components are the change of muscle, fat, and bone proportions. The muscle and fat represent the edible portion and shows higher commercial value. The weight gain results in an increased muscle and fat, with higher or lower fat gain dependent of the genotype. The works of Lambuth et al. (1970), Solomon et al. (1980), Santos-Silva et al. (2002), Kremer et al. (2004), Pérez et al. (2007), and Abdullah and Qudsieh (2011) corroborate this information, showing greater musculosity, conformation and fatness, and consequently specific qualitative attributes due to the higher amount of fat, as the slaughter weight increases.

The production models evaluated showed a similarity to use meat breeds and crosses directed to the production of meat, with a meat breed as terminal sire. In general, at the state of São Paulo this practice is common, even in farms with low technology. This contributed to minimize the effects of breed within and between the production models. The main effects were due the production model where the Cordeiro Paulista provided younger and heavier lambs with better body condition, higher musculosity and better fatness. The meat from Cordeiro Paulista lambs showed better quality attributes as better colour, lower shear force, and better sensorial traits. Even with lower ω3 content for Cordeiro Paulista meat, there was no difference for the proportion of unsaturated fatty acids between the productions models, which was higher than saturated fatty acids.

From the nutritional point of view, the Cordeiro Paulista model presents the disadvantage of lower concentration of ω3 fatty acids and, consequently, higher ω6:ω3 ratio in comparison to the Traditional model. Simopoulos (2002) highlights that high level of ω6, which increases ω6:ω3 ratio, promote cardiovascular diseases, cancer, inflammatory diseases, and autoimmunity disorders. Thus, the search for an increase in the level of meat ω3 fatty acids, with a lower ω6:ω3 ratio, can improve the nutritional quality of the meat resulting in benefits for human health.

The employment of creep feeding and finishing in feedlot used in the Cordeiro Paulista model may facilitate diet manipulation in order to change the fatty acids profile of the meat, with an increase in the concentration of ω3 fatty acids. This manipulation may be carried out by using different vegetable-origin ingredients, as occurred in the studies made by Rodrigues et al. (2010) and Karami et al. (2013), and vegetable oils, such as linseed, as suggested by Zhang et al. (2013).

The production system strongly influences animal productivity and the quality of the products, mainly by means of weight and finishing of the animals and kind of diet used. Several works present results of the influence of the production system on the quality of lamb meat and the great importance of the effect of weight and finishing of the animals and the relations between diet, fatty acids profile and sensorial characteristics, such as aroma and flavor (D’Alessandro et al., 2012; Fisher et al., 2000; Melton, 1990; Sahudo et al., 1996, 1998, 2000, 2007; Duckett and Kuber, 2001; Geay, 2001; Font i Furnols et al., 2006, 2009; Resconi et al., 2010).

In fact, the Traditional production model should be more characterized, especially in relation to the composition of the diet of the animals, aiming to elucidate the differences of aroma and flavor intensities between the production models, once the results obtained are opposite to the ones found by Sahudo et al. (2000), who determined positive correlations between meat aroma, flavor and ω3 fatty acids content from diets based on forages, and negative correlations of these sensorial characteristics with ω6 fatty acids content from diets based on concentrates.

Probably, the typically higher intense aroma and flavor found in the meat from the Cordeiro Paulista model is due to the higher carcass fatness of the animals produced in this model, in agreement with the results presented by Muela et al. (2010), who associated the higher intensity of these sensorial characteristics to the aromatic composts present in the higher amount of fatty tissue in the carcass. Carcasses from Cordeiro Paulista model showed higher subcutaneous fat thickness and better fat cover distribution. As the fatness increase is observed a higher contribution of fatty acids.
from triglycerides that show higher proportion of monounsaturated fatty acids. Meat samples from Cordeiro Paulista showed higher proportion of C18:1 (Table 5) and according to Dryden and Maechello (1970), Westerling and Hedrick (1979), and Zembayashi et al. (1995) this fatty acid is correlated with high flavor scores in panel evaluations.

Resconi et al. (2010) emphasize the inconsistence of the results of the effects of the diet on the aroma and flavor of the sheep meat because some studies report more intense aroma and flavor with animals fed with more concentrate than pasture and other studies present opposite results. However, the authors point out the higher influence of the aromatic compounds on aroma and flavor of the sheep meat in comparison with the effects of the fatty acids, and determined that the intensification of the production system by using diets based on concentrate affects the aromatic compounds concentrations, making the aroma and taste of the meat more intense.

5. Conclusion

The farms considered in the Cordeiro Paulista model produced carcasses with better conformation and fatness and soft meat with better color, flavor and texture.

It is necessary to make a better evaluation of the ingredients composition of the diet of the animals in order to adjust the composition of polysaturated fatty acids, especially ω3.

Conflicts of interest

None.

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