Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1806-2636
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v39i1.32749

Time on feedlot and sexual effects on animal performance and characteristics of lamb's meat

Madeline Rezende Mazon[1], Roberta Ferreira Carvalho[1], Domingos Marcelo Cenachi Pesce[2], Saulo da Luz e Silva[1], Sarita Bonaguiro Gallo[1*] and Paulo Roberto Leme[1]

*[1]Faculdade de Zootecnia e Engenharia de Alimentos, Universidade de São Paulo, Rua Duque de Caxias Norte, 225, Jardim Elite, 13635-900, Pirassununga, São Paulo, Brazil. [2]Pontifícia Universidade Católica de Minas Gerais, Poços de Caldas, Minas Gerais, Brazil. *Author for correspondence. E-mail: mad-mazon@usp.br*

ABSTRACT. For this research 48 male lambs were divided in randomized blocks in a factorial design, having as factors sexual condition (castrated or uncastrated) and time on feed (36 or 78 days). High grain diet was monitored daily to measure the performance of the animal nutrition. The characteristics of the carcass and meat were taken for the fatty acids profile and sensorial analysis. The effect of the factors as sexual condition and time on feed, and the interaction between them, were evaluated by analysis of variance using the GLM procedure of SAS software and the treatment averages were compared by Student's T test. The uncastrated animals presented greater weight gain and dry matter intake, better feed efficiency, and larger loin area. More time on feed resulted in higher weight at slaughter. Parameters such as pH, color, meat tenderness and sensorial attributes were not affected by treatments. For the fatty acid profile there was effects and interactions between sexual condition and time on feed. It is concluded that castration should not be used when the animal is young and slaughtered and feed intensively, but neutering can be interesting to improve the fatty acid profile of the meat.

Keywords: castrated, Dorper, fatty acids, meat, Santa Inês, sheep.

Período de confinamento e efeito do sexo sobre o desempenho e características de qualidade da carne de cordeiros

RESUMO. No experimento realizado, foram utilizados 48 cordeiros machos divididos em blocos casualizados, em esquema fatorial, sendo tais fatores: a condição sexual (castrado ou não castrado) e tempo de confinamento (36 ou 78 dias). Uma dieta rica em grãos foi ofertada e controlada diariamente para medir o desempenho da nutrição animal, as características da carcaça e da carne foram avaliadas, e foi feita análise sensorial. A condição sexual e o tempo em confinamento, bem como a interação entre eles, foram avaliados por análise de variância, utilizando o procedimento GLM do software SAS e as médias dos tratamentos foram comparadas pelo teste t de estudante ($p < 0,05$). Os animais não castrados apresentaram maior ganho de peso e consumo de matéria seca. Eles também tiveram uma melhor eficiência alimentar e área de lombo. Mais tempo no confinamento resultou em maior peso ao abate. Parâmetros como pH, cor, maciez da carne e atributos sensoriais não foram afetados pelos tratamentos. Para o perfil de ácidos graxos, houve efeitos e as interações entre condição sexual e tempo de confinamento. Concluiu-se que a castração não deve ser usada quando o animal é novo e criado em sistema intensivo, mas a castração pode ser interessante para melhorar o perfil de ácidos graxos da carne.

Palavras-chave: castração, Dorper, ácidos graxos, carne, Santa Inês, ovinos.

Introduction

Several management techniques are employed in finishing lambs to increase performance and improve meat quality. Among them, castration facilitates the management, decreases aggressive behavior, and improve carcass characteristics, mainly through greater fat deposition and carcass yield, which can influence the commercial value of meat (Fisher, Bray, & Johnstone, 2010; Fogarty & Mulholland, 2012).Castration also reduces sheep aroma and flavor, but non-castrated fed intensively for short time should also produce meat without bad taste and with enough fat deposition. Animals that remain less time on feed and are harvested earlier might have less influence of sexual condition in carcass and meat characteristics. In some studies no statistical difference between males not castrated and castrated based on performance, carcass characteristics, and meat quality (Fogarty & Mulholland, 2012; Vargas Junior et al., 2014).

This trial was proposed to verify as far as non-castrated intensively fed lambs may produce high quality meat, with the same acceptability by the consumer of the meat from castrated animals. The Dorper x Santa Inês cross, commonly used by Brazilian farmers, show good fat deposition which can be increased by castration and age and this can accentuate the characteristic sheep flavor. Therefore, this work was developed to evaluate the effects of sexual condition associated with different time on feed on the feedlot efficiency and carcass characteristics and meat quality.

Material and methods

Forty eight Dorper x Santa Inês lambs (32.4 ± 5.04 kg at 104 days) were separated into 24 pens, two per pen, according to initial weight. Half the lambs were castrated using an emasculation plier before the 14 days adaptation period. After that, the animals were fed a high energy diet (Table 1), offered *ad libitum* once a day, for 36 or 78 days before harvest. Animal weight was collected every 14 days.

Table 1. Chemical composition of nutrients diet of lambs with different sexual conditions and confinement time.

Nutrients	Diet	Whole corn grain	Protein concentrate	Cost cross hay
Dry Matter (%)	89.0	87.9	91.2	94.7
Chemical composition, % of DM				
Mineral matter	3.0	1.2	29.8	7.3
CP	16.6	10.0	42.7	11.6
Ether extract	4.2	4.5	4.2	0.2
Non-nitrogen extract	69.2	81.8	26.2	52.0
ADF	9.0	6.2	11.5	37.7
NDF	18.0	11.8	25.1	82.1
TDN[1]	76.0			
Ca	0.9	0.01	4.78	0.53
P	0.3	0.17	1.27	0.20

[1]Total Digestible Nutrients. Values estimated using the equation: %TDN = 40.2625 + 0.1969% PB + 0.4228% ENN + 1.1903% EE 0.1379% FB

Carcasses were individually labeled and weighed to determine hot carcass weight (HCW) and weighed again to obtain cold carcass weight (CCW) after 24 hours of chilling (0-2°C). The pH and temperature of the measured meat at one e twenty four hours *post-mortem*.

After this time, the left sides of the carcasses were ribbed between the 12 and 13th ribs, to measure *Longissimus thoracis et lumborum muscle area* (LMA) and back fat thickness (BFT). The BFT was obtained at site C (45 mm from the back line). Two samples of *Longissimus dorsi* muscle (2.5 cm thick) were taken, between the 10 and 12th ribs. Samples were allowed to bloom for 20 min, then color (L*, a*, b*) was measured at three different points in one sample using a Konica Minolta spectrophotometer. Warner Bratzler shear force (SF) measurements were determined according to methodology suggested by Shackelford, Wheeler, and Koohmaraie (2004).

For sensory analyses, samples were thawed (24 hours at 3-4°C), and placed in 10% brine (salt water) for 15 min. Each sample was roasted in an electric broiler until a temperature of 35°C was reached. Then, the sample was flipped and roasted until the internal temperature reached 70°C. Roasted samples were cut parallel to the muscle fibers to form 1.5 cm cubes. Samples were then placed in an oven (60°C) until the completion of tests, which were performed within 30 min of preparation. A sensory panel was carried out, with nine trained tasters who evaluated six attributes: sheep aroma, rancid aroma, tenderness, sheep flavor, rancid flavor and juiciness, using a nine point unstructured scale. Aroma and taste was rated extremely weak to extremely strong, tenderness was rated as soft to hard, and juiciness was rated as dry to juicy.

For analysis of fatty acids, samples were thawed for 24 hours at 3-4°C. Following, 5 g of meat were extracted from the center of each steak for fat and methylation extraction. Fatty-acid profiles were assessed by gas chromatography (Trace 2000, Thermo Finnigan, MA, USA) using fused silica capillary columns (100 × 0.25 mm with 0.2 μm film thickness) and helium as the carrier gas. Identification and recovery rate of methyl esters from the fatty acids were performed by comparison with a known standard. Total amounts of saturated, unsaturated, monounsaturated, polyunsaturated, omega-6, omega-3 fatty acids, as well as related molecules were calculated from the fatty-acid profiles.

The experimental design was randomized blocks with factorial arrangement 2 x 2 for the purpose of sexual condition (spayed or neutered) and confinement time (36 or 78 days). Twelve replicates per treatment were used, respectively, The effect of the factors of sexual condition and confinement time, and the interaction between them were evaluated by analysis of variance using the GLM procedure of SAS software (SAS Institute Inc., Cary, NC), and the treatment means compared by the Student t test, according to the following Equation 1:

$$Yijk = \mu + Si + Ij + SIij + eijk \quad (1)$$

where:
Yijk = value k characteristic of the animal, under the effect of castration (i = 1 castration, castrated not i = 2) and the age of slaughter j (j = 1 36 days, j =2 78 days);

μ = overall average;
Sl = fixed effect of castration l (i = 1 castration, i = 2 castrated not);
Ij = fixed effect of j slaughter age (j = 1 36 days, j =2 78 days);
SIij = fixed effect of the interaction of i castration slaughter time j;
eijk = random error in Yijk animal [~ NID (0, δ^2e)]

Results and discussion

At the end of the experimental period final body weight for the rams was 5.7 kg higher (p = 0.0003), average daily gain was 67 g day^{-1} higher (p = 0.0013), dry matter intake was higher (p = 0.0019), and feed efficiency was 4.6 g kg^{-1} higher (p = 0.0060), compared to wethers (Table 2). Lambs fed for a longer period, as expected, had higher carcass weight when compared with animals that spent less time in the feedlot however, with lower feed efficiency (Table 2).

Table 2. Effects of sex-type and time on feed on performance traits of feedlot finished lambs.

Traits	Sex-type		Time on feed		p value*		
	Wether	Ram	36	78	SEM*	ST**	TF***
Initial weight, kg	32.1	32.5	32.0	32.6	0.81	0.6903	0.6147
Final weight, kg	46.6	52.3	44.5	54.5	1.02	0.0003	< 0.0001
Average daily gain, g	270	337	327	279	0.01	0.0013	0.0185
Dry matter intake, kg	1.15	1.28	1.28	1.15	0.03	0.0019	0.0024
Feed efficiency, kg kg^{-1}	0,23	0,28	0,27	0,24	0.01	0.0060	0.1001

*SEM - Standard errors of the mean. Value of statistical probability by T Student's test. **Sex-type. ***Time on feed.

Fogarty and Mulholland (2012) observed that rams had higher body weight at 70 and 170 days of life when compared with females. That resulted in heavier and leaner carcasses. There is also a superiority of ram animals over females when evaluating weight gain and feed efficiency of animals in feedlot (Vargas Junior et al., 2014). Feed efficiency was higher in young lambs; harvest weight should be optimized in relation to growth performance and adequate quality of meat (Shirima et al., 2014). D'Alessandro et al. (2013), observed greater final weight, HCW for lambs slaughtered after 60 days on feed, when compared with lambs fed for 45 days.

Rams Lambs not castrated had higher final body weight and carcass weight, but dressing percentage, carcass yield, *Longissimus* muscle area, back fat thickness, pH, cooking loss, color and Warner Braztler Shear Force (WBSF) were not affected (Table 3). However, there was a trend for less tender meat for wethers than for rams.

Longer Time on feed in the feedlot increased both hot and cold carcass weight increasing back fat thickness and *Longissimus* area. Also resulted in lower meat pH. Animals fed for 78 days had a pH of 6.3, whereas, animals fed 36 days had a pH of 6.0. Decrease in pH was more apparent at 24 hours *post-mortem*, with values 5.5 for animals fed for 78 days and 5.7 for animals fed for 36 days. Back fat thickness and the pH were probable factors affecting the WBSF values, meat from animals fed for 78 days were more tender when compared with animals fed for 36 days (Table 3) Time on feed did not affect dressing percentage, thaw loss, cooking loss, or color values.

Table 3. Effects of sex-type and time on feed on carcass traits and meat quality of feedlot finished lambs.

Traits	Sex-type		Time on feed		p value		
	Wether	Ram	36	78	SEM*	ST**	TF***
Hot carcass weight, kg	22.6	24.8	21.0	26.5	0.53	0.005	< 0.0001
Dressing percentage, %	48.4	47.4	47.3	48.6	0.60	0.263	0.138
Cold carcass weight, kg	22.2	24.4	20.6	26.0	0.52	0.005	< 0.0001
Drip loss, %	1.9	1.8	1.9	1.8	0.12	0.761	0.481
Eye muscle area, cm^2	16.1	18.0	15.8	18.3	0.52	0.010	< 0.0001
Back fat thickness, mm	3.7	3.1	2.8	4.0	0.36	0.289	0.035
pH_1	6.2	6.2	6.0	6.3	0.04	0.962	0.0003
Ultimate pH	5.6	5.6	5.7	5.5	0.03	0.334	0.0001
Cooking loss, %	13.2	14.3	12.9	14.6	0.61	0.223	0.062
L*	32.8	33.3	34.8	31.2	1.36	0.814	0.069
a*	16.4	16.4	15.5	17.2	0.72	0.995	0.102
b*	14.8	14.8	15.3	14.3	0.61	0.966	0.269
Shear Force, kg	3.7	3.2	3.9	3.0	0.19	0.062	0.0014

*SEM - Standard errors of the mean. Value of statistical probability by T Student test. **Sex-type. ***Time on feed.

In the current study LMA increased in rams, which was expected. This increase may be due to muscle hypertrophy, stimulation by testosterone treatment in later postnatal periods, direct or indirect satellite cell proliferation or muscle protein synthesis (Yoshioka, Boivin, Bolduc, & St-Amand, 2007). According to Haddad, Husein, and Swedan (2006), there was no effect of castration in lambs for HCW, CCW, dressing percentage, or LMA.

Fogarty and Mulholland (2012) observed higher for BFT (3.9 mm) in wether lambs when compared with ram animals (2.9 mm). Sales (2014) found that wether lambs had greater dressing percentage and BFT, but LMA was lower when compared with rams. Kiyma et al. (2000) found that fat deposition in wethers require a prolonged testosterone-deficient condition, whereas suppression of sexual behavior and reduction of feed efficiency occurs more rapidly after castration.

The present results of SF were different from the results reported by Sales (2014), where lower SF values were observed for wethers compared with rams. These findings may be attributed to lower concentrations of soluble and insoluble collagen in muscle. Skapetas, Sinapis, Hatziminaoulglou, Karalazos, and Katanos (2006), reported higher dressing percentage in Greek mountain breed lambs

slaughtered after 45 days on feed, dressing percentage decreased at 60 days, and further increased at 75 and 90 days on feed. These results were likely attributed to higher growth rate of lambs at 45 days on feed and decreases at 60 days were attributed to the weaning stress that decreases the weight gain. Heavier animals can have a greater reserve of muscle glycogen at slaughter, and this can cause a greater pH decline, resulting in higher shear force values (Oliveira et al., 2015; Santos et al., 2015).

Lind, Berg, Eilertsen, Hersleth, and Eik (2011) observed the higher tenderness of female meat when compared to males, and they found that this was correlated with higher fat content. These findings were likely due to the protection of fat in low temperatures, reducing muscle fibers shortening by cold. According to Oliveira et al. (2015) and Santos et al. (2015) one cause of meat toughness is reduced sarcomere length, but if it reaches a final pH value below 6.2 the sarcomere length appears to increase. This suggests that increased tenderness can be achieved through longer feeding regimes. These findings corroborate what was found in our present study, where lambs slaughtered after 78 days of feeding, had lower pH 24, as well as lower shear force, and more tender meat. D`Alessandro et al. (2013), observed no differences when evaluating meat color from lambs slaughtered at 45 or 60 days on feed.

Sex-type affected juiciness; wethers were juicier than rams (Table 4). Moreover, time on feed affected tenderness, meat from animals fed 78 days was evaluated as less tender than meat from animals fed 36 days by trained consumer sensory analysis. Sheep smell, rancid smell, tenderness, sheep flavor and rancid flavor not were affected by sex-type.

Table 4. Attributes evaluated by sensory analysis of meat from lambs with different sex-type and time on feed.

Attributes	Sex-type		Time on feed		p value*		
	Wether	Ram	36	78	SEM*	ST**	TF***
Sheep Smell	4.69	4.54	4.66	4.57	0.11	0.287	0.55
Rancid Smell	1.26	1.26	1.22	1.3	0.08	0.98	0.318
Tenderness	3.14	3.28	3.84	2.58	0.13	0.466	< 0001
Sheep Flavor	4.37	4.49	4.6	4.26	0.13	0.499	0.059
Rancid Flavor	1.61	1.75	1.66	1.71	0.12	0.32	0.704
Juiciness	4.63	3.87	4.2	4.29	0.14	0.0003	0.654

*SEM - Standard errors of the mean. Value of statistical probability by T Student test. **Sex-type. ***Time on feed.

According to Noble (1996), interactions between food flavor and aroma may not be identified in sensory evaluations, even with a rigorously trained panel. Each taster evaluates food in a different way, depending of personal preferences and variations in individual sensitivity. Therefore, this could explain the lack of significant results for flavor and aroma found in this work. Greater juiciness of was observed in castrated animals when compared to non-castrated animals, and this may result from higher growth of skeletal muscle and lower fat deposition in non-castrated animals compared with castrated animals. According to Osório, Osório, and Sañudo (2009), meat tenderness and juiciness are correlated with higher fat content in carcasses.

Differences in tenderness may be due to greater ($p = 0.0357$) subcutaneous fat thickness in animals slaughtered after 78 days (4.0 mm) compared with animals slaughtered after 36 days (2.85 mm). Subcutaneous fat affects meat tenderness, through the protection of the carcass from cold shortening, which can occur during storage at low temperatures. Furthermore, increased levels of subcutaneous fat slow drops in temperature and pH during chilling period, inhibiting glycolysis and producing a pH (5.4) level typical of tender meat.

There was no effect of treatment to total saturated and unsaturated fatty acid. Palmitic acid (C16:0) is the saturated acid present in greater quantity. Presence of palmitic acid was affected by sex-type. There was a greater concentration found in rams (24.15%) than wethers (23.01%) (Table 5). Animals fed 36 days had higher values for C18:19, C18:2C9C12, this result might be explained by less time on feed with high content of grain. Average ω6:ω-3 was 24%, ideally, this ratio should be less than 4 and should not exceed 25 (Wood et al., 2003, Dervishi et al., 2011, Aferri et al., 2012). Diets high in grains, for example corn, can increase the ω6 and polyunsaturated acids changing the flavor and smell. Grass based diets increase ω3 in the meat, which contributes to healthy meat (Larick & Turner, 1990).

Table 5. Profile of the major fatty acids (%) found in lamb with different sex-type and time on feed.

Fatty Acid	Sex-type		Time on feed		p value*			
	Wether	Ram	36	78	SEM	ST**	TF***	STxTF
C15:0	0.499	0.530	0.535	0.494	0.027	0.423	0.311	0.566
C16:0	23.019	24.153	23.265	23.907	0.349	0.027	0.204	0.200
C18:0	11.931	11.025	11.662	11.295	0.428	0.143	0.549	0.243
SFA[1]*	40.407	40.766	40.655	40.517	0.608	0.678	0.874	0.956
C17:1	0.148	0.140	0.255	0.034	0.076	0.944	0.047	0.924
MUFA[2]*	51.039	50.846	49.948	51.936	0.606	0.824	0.027	0.026
C18:2C9T11	0.239	0.216	0.262	0.192	0.023	0.476	0.036	0.668
C18:2T10C12	0.017	0.015	0.018	0.013	0.002	0.652	0.147	0.128
PUFA[3]*	8.553	8.387	9.396	7.545	0.65	0.858	0.052	0.040
UFA[4]★	59.593	59.234	59.344	59.482	0.606	0.678	0.874	0.956
UFA:SFA	1.487	1.461	1.470	1.478	0.035	0.619	0.874	0.858
PUFA:SFA	0.216	0.208	0.215	0.188	0.018	0.776	0.081	0.083
ω-6[a]	2.388	2.017	2.686	1.719	0.397	0.509	0.092	0.107
ω-3[b]	0.232	0.286	0.289	0.228	0.019	0.057	0.036	0.328
ω6:ω3	9.971	7.157	9.222	7.906	1.144	0.089	0.423	0.113

[a]ω-6 (C18:1c12 + C18:2c9c12 + C18:2t10c12 + C18:3n6 + C20:3n6). [b]ω-3 (C18:1c15 + C18:2t11c15 + C18:3n3 + C20:3n3). *SEM - Standard errors of the mean. Value of statistical probability by T Student test. **Sex-type. ***Time on feed.

There were interactions between sex-type and time on feed for C12:0, C14:1C9, C15:1, C17:0, C18:1C9, C18:1T16, C18:2C9C12 acids, monounsaturated, polyunsaturated and ω6 (Table 6). Wethers fed 36 days had higher values for polyunsaturated and ω6, however, wethers fed 78 days had higher values for monounsaturated acids. Omega 3 was affected by time on feed (p = 0,0043), young animals fed 36 days had more concentration of ω3 than animals fed 78 days (Table 6). Additionally, rams had less fatty acid content than wethers.

Table 6. Percentages of fatty acids showing significant interactions in lamb with different sex-type and time on feed.

Fatty acids (%)	Wether	Wether	Ram	Ram	SEM*
	36 days	78 days	36 days	78 days	
C12:0 (lauric)	0.1350	0.080	0.094	0.101	0.012
C14:1C9 (myristoleic)	0.1240	0.087	0.106	0.114	0.009
C15:1	0.0126	0.001	0.000	0.004	0.002
C17:0 (heptadecanoic)	1.5330	1.856	1.925	1.536	0.167
C18:1C9 (oleic)	40.3190	44.788	41.764	41.608	0.866
C18:1T16	0.1200	0.135	0.128	0.115	0.006
C18:2C9C12 (linoleic)	6.4910	4.729	5.648	5.916	0.462
MUFA	49.0410	53.037	50.856	50.836	0.864
PUFA	10.4580	6.647	8.333	8.443	0.920

MUFA: Monounsaturated fatty acid; PUFA: Polyunsaturated fatty acid; *SEM - Standard errors of the mean.

In this study, desirable fatty-acid levels in castrated animals slaughtered after 36 and 78 days in on feed were 72 and 70%, respectively, and 71% in both times in intact animals. No interactions were found between sexual condition and time on feed for CLA. However, there was an effect of time on feed on CLA (p = 0.0361). These molecules play important physiological roles and have anticarcinogenic and antilipogenic properties, C18: 2C9T11 accounts for ~80% of the total CLA in ruminants, while C18: 2T10C12 accounts for only 3-5%. Sheep fed high concentrate diets have greater levels of CLA (French et al., 2000). In this experiment, the C18:2C9T11 isomer of CLA had a significant effect with time in the feedlot, and it was found at higher levels (p = 0.0361) in animals slaughtered after 36 days the feedlot.

The highest level of oleic acid was measured with castrated animals slaughtered after 78 days of feedlot (44%). Similar results were reported by Yousefi, Kohram, Shahneh, Nik-Khah, and Campbell (2012), who found that, the C18:1C9 fatty acid made up 38.5% of the fatty acids in sheep meat of the Chall and Zel breeds. This fatty acid is known to decrease plasma cholesterol and LDL levels (Tejeda, Pea, & Andrés, 2008). The observed increase in oleic acid levels in castrated animals that spent more time on feed was likely due to increased intramuscular fat deposition.

Based on the levels of oleic and palmitic acids, it appears that meat from castrated animals slaughtered after 78 days of feeding was the healthiest of the four treatments we analyzed. This treatment had the highest concentration of oleic acid (44%), which has beneficial effects for humans. Whereas palmitic acid has been reported to increase plasma cholesterol (Tejeda et al., 2008), these authors found no significant effects (p = 0.1999).

MUFA levels showed a significant sexual condition x time on feed interaction (p = 0.0260), which was higher in castrated animals slaughtered after 78 days of time on feed. Similarly PUFA levels also showed a significant interaction (p = 0.0403), which was higher in castrated animals slaughtered after 36 days of time on feed. MUFA levels were the highest in animals fed high concentrate diets for long periods, and this can increase fat accumulation and marbling. However PUFA levels were the highest in animals confined for short periods. In general, the PUFA: SFA ratio decreases as the percentage of overall fat increases (De Smet, Raes, & Demeyer, 2004).

In our experiment no significant interactions were observed with respect to the PUFA:SFA ratio. Mean value of 0.21 was below the threshold used to characterize healthy foods (0.40) (Wood et al., 2003). Similar results were found by Leão et al. (2011), who measured a PUFA:SFA value of 0.17. According to Scollan et al. (2001) this ratio is generally low in ruminant meat and may range from 0.06 to 0.15. This range is due to differences in the biohydrogenation of polyunsaturated fatty acids by microorganisms in the rumen, leading to higher levels of saturated and monounsaturated fatty acids (French et al., 2000).

No interaction was observed between sexual condition and time in the feedlot for unsaturated fatty acids, these findings were similar to those of Leão et al. (2011). Unsaturated fatty acids are undesirable for meat preservation, particularly those containing double bonds which can rapidly oxidize. This can lead to rancidity and color deterioration, which are key factors in the sensory evaluation of flavor and aroma in cooked meat (Yousefi, Kohram, Shahneh, Nik-Khah, & Campbell, 2012).

Conclusion

Castration should not be used when the lamb is intensively fed for short time to maximize

performance or carcass characteristics, but neutering can be interesting to improve the fatty acid profile of the meat.

References

Aferri, G., Leme, P. R., Pereira, A. S. C., Silva, S. D. E., Putrino, S. M., Freitas, J. E., & Renno, F. P. (2012). Fatty acid composition of the *longissimus dorsi* muscle in crossbred steers fed different sources of fatty acids *Revista Brasileira de Zootecnia, 41*(7), 1706-1712,

D'Alessandro, A. G., Maiorano, G., Ragni, M., Casamassima, D., Marsico, G., & Martemucci, G. (2013). Effects of age and season of slaughter on meat production of light lambs: Carcass characteristics and meat quality of Leccese breed. *Small Ruminant Research, 114*(1), 97-104.

De Smet, S., Raes, K., & Demeyer, D. (2004). Meat fatty acid composition as affected by fatness and genetic factors: a review. *Animal Research, 53*(2), 81-98.

Dervishi, E., Serrano, C., Joy, M., Serrano, M., Rodellar, C., & Calvo, J. H. (2011). The effect of feeding system in the expression of genes related with fat metabolism in semitendinous muscle in sheep. *Meat Science, 89*(1), 91-97.

Fisher, M. W., Bray, A. R., & Johnstone, P. D. (2010). Implications of removing or altering the testicles of ram lambs on the financial returns from carcasses. *New Zealand Journal of Agricultural Research, 53*(2), 135-143.

Fogarty, N. M., & Mulholland, J. G. (2012). Growth and carcass characteristics of crossbred lambs in various production systems. *Animal Production Science, 52*(5), 373-381.

French, P., Stanton, C., Lawless, F., O'Riordan, E. G., Monahan, F. J., Caffrey, J., & Moloney, A. P. (2000). Fatty acid composition, including conjugated linoleic acid of intramuscular fat from steers offered grazed grass, grass silage or concentrate based diets. *Journal of Animal Science, 78*(11), 2849-2855.

Haddad, S. G., Husein, M. Q., & Swedan, R. W. (2006). Effects of castration on growth performance and carcass characteristics of Awassi lambs fed high concentrate diet. *Small Ruminant Research, 65*(1-2), 149-153.

Kiyma, Z., Adams, T. E., Hess, B. W., Riley, M. L., Murdoch, W. J., & Moss, G. E. (2000). Gonadal function, sexual behavior, feedlot performance, and carcass traits of ram lambs actively immunized against GnRH. *Journal of Animal Science, 78*(9), 2237-2243.

Larick, D. K., & Turner, B. E. (1990). Flavour characteristics of forage-and grain-fed beef as influenced by phospholipid and fatty acid compositional differences. *Journal of Food Science, 55*(2), 312-368.

Leão, A. G., Sobrinho, A. G. S., Moreno, G. M. B., Souza, H. B. A., Perez, H. L., & Loureiro, C. M. B. (2011). Características nutricionais da carne de cordeiros terminados com dietas contendo cana-de-açúcar ou silagem de milho e dois níveis de concentrado. *Revista Brasileira de Zootecnia, 40*(5), 1072-1079.

Lind, V., Berg, J., Eilertsen, S. M., Hersleth, M., & Eik, L. O. (2011). Effect of gender on meat quality in lamb from extensive and intensive grazing systems when slaughtered at the end of the growing season. *Meat Science, 88*(2), 305-310.

Noble, A. C. (1996). Taste – aroma interactions. *Trends in Food Science e Technology,* 7(12), 439-443.

Oliveira, L. S., Mazon, M. R., Carvalho, R. F., Pesce, D. M. C., Silva, S. L., Gallo, S. B., & Leme, P. R. (2015). Effects of processing corn on the carcass traits and meat quality of feedlot lambs. *Tropical Animal Health and Production, 47*(5), 883-887.

Osório, L. C. S., Osório, M. T. M., & Sañudo, C. (2009). Características sensoriais da carne ovina. *Revista Brasileira de Zootecnia, 38*(spe), 292-300.

Sales, J. (2014). Quantification of the effects of castration on carcass and meat quality of sheep by meta-analysis. *Meat Science, 98*(4), 858-868.

Santos, V. A. C., Cabo, A., Raposo, P., Silva, J. A., Azevedo, J. M. T., & Silva, S. R. (2015). The effect of carcass weight and sex on carcass composition and meat quality of "Cordeiro Mirandês"—Protected designation of origin lambs. *Small Ruminant Research, 130*(7), 136-140.

Scollan, N. D., Choi, N., Kurt, E., Fisher, A. V., Enser, M., & Wood, J. D. (2001). Manipulating the fatty acid composition of muscle and adipose tissue in beef cattle. *British Journal of Nutrition, 85*(1), 115-124.

Shackelford, S. D., Wheeler, T. L., & Koohmaraie, M. (2004). Technical Note: Use of belt grill cookery and slice shear force for assessment of longissimus tenderness. *Journal of Animal Science, 82*(1), 238-241.

Shirima, E. J. M., Mtenga, L. A., Kimambo, A. E., Laswai, G. H., Mgheni, D. M., Mushi, D. E., … Safari, J. G. (2014). Influence of age at entry and level of concentrate feeding on growth and carcass characteristics of feedlot-finished Tanzanian long-fat-tailed sheep. *Tropical Animal Health Production, 46*(5), 815-822.

Skapetas, B., Sinapis, E., Hatziminaoulglou, J., Karalazos, A., & Katanos, J. (2006). Effect of age at slaughter on carcass characteristics and carcass composition in lambs of mountain Greek breed. *Czech Journal of Animal Science, 51(7), 311-317.*

Tejeda, J. F., Pea, R. E., & Andrés, A. I. (2008). Effect of live weight and sex on physico-chemical and sensorial characteristics of Merino lamb meat. *Meat Science, 80*(4), 1061-1067.

Vargas Junior, F. M., Martins, C. F., Pinto, G. S., Ferreira, M. B., Ricardo, H. A., Leão, A. G., ... Teixeira, A.

(2014). The effect of sex and genotype on growth performance, feed efficiency, and carcass traits of local sheep group Pantaneiro and Texel or Santa Inês crossbred finished on feedlot. *Tropical Animal Health Production, 46*(5), 869-875.

Wood, J. D., Richardson, R. I., Nute, G. R., Fisher, A. V., Campo, M. M., Kasapidou, E., … Enser, M. (2003). Effects of fatty acids on meat quality: a review. *Meat Science, 66*(1), 21-32.

Yoshioka, M., Boivin, A., Bolduc, C., & St-Amand, J. (2007). Gender difference of androgen on skeletalmuscle transcriptome. *Journal of Molecular Endocrinology, 39*(1), 119-133.

Yousefi, A. R., Kohram, H., Shahneh, A. Z., Nik-Khah, A., & Campbell, A. W. (2012). Comparison of the meat quality and fatty acid composition of traditional fat-tailed (Chall) and tailed (Zel) Iranian sheep breeds. *Meat Science, 92*(4), 417-422.

Received on July 15, 2016.
Accepted on October 5, 2016.