

Meat quality of white and natural colored male lambs raised in the Pampa Biome¹

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ABSTRACT

Sheep meat quality is influenced by a number of factors either intrinsic (species, breed, sex, and age) or extrinsic (nutrition, environment, and pre- and post-slaughter handling) to the animal. However, it is not known whether wool fiber color variations within the same breed can influence the instrumental and sensory characteristics of the meat. Thus, the objective of this study was to investigate the effect of the genetic group on the instrumental and sensory characteristics of meat of white and natural colored Corriedale lambs. The 29 lambs (13 natural colored and 16 white) used in the experiments were raised on natural pasture under extensive grazing conditions in the region of the Pampa Biome, Rio Grande do Sul, Brazil. The animals were slaughtered at average age of 18 months. Meat evaluations were performed on samples from *longissimus dorsi* muscles. The analysis of variance was used to evaluate the effect of the genetic group and the means were compared by the F test. The instrumental analysis showed that meat of natural colored lambs had darker red color, higher 24 h pH, and higher scores for fat cover and texture. Sensory profiling was performed by nine trained panelists in four sessions. The sensory evaluation showed that natural colored lambs had darker red color, higher scores of fat taste and characteristic taste to the species. Despite significant differences in some sensory aspects, the samples were equally accepted by the panelists. Meat of natural colored Corriedale lambs had different instrumental and sensory profiles from that of white lambs.

Keywords: *Ovis aries*; sensory analysis; *longissimus dorsi*; Instrumental analysis.

RESUMO

Qualidade da carne de cordeiros Corriedale brancos e naturalmente coloridos criados no Bioma Pampa

Fatores intrínsecos (espécie, raça, sexo e idade) e extrínsecos ao animal (nutrição, ambiente e manejos pré e pós-abate) interferem na qualidade da carne ovina. Contudo, não se sabe como variações da coloração das fibras de lã dentro de uma mesma raça podem influenciar as características instrumentais e sensoriais da carne. Assim, objetivou-se com este trabalho investigar o efeito do grupo genético dos animais sobre as características instrumentais e sensoriais da carne de cordeiros Corriedale naturalmente coloridos e brancos. Foram utilizados 29 animais (13 naturalmente coloridos e 16 brancos), criados na região do Bioma Pampa, no Rio Grande do Sul, em condições extensivas de pastagem natural melhorada e abatidos com idade média de 18 meses. As avaliações da carne foram realizadas no músculo *longissimus*

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dorsi. Foi utilizada a análise de variância para avaliar o efeito do grupo genético e as médias foram comparadas pelo teste F. Na análise instrumental a carne de cordeiros naturalmente coloridos apresentou coloração mais escura e valores de pH 24 horas, escore de cobertura de gordura e textura mais elevados. A caracterização sensorial foi obtida em quatro sessões utilizando nove julgadores treinados. Nesta avaliação, animais naturalmente coloridos apresentaram coloração da carne mais escura, sabor à gordura e sabor característico à espécie mais elevadas. Apesar de diferenças significativas em alguns aspectos sensoriais, as amostras foram igualmente aceitas pelos julgadores. Cordeiros Corriedale naturalmente coloridos apresentam características instrumentais e sensoriais da carne distintas de cordeiros brancos.

Palavras chave: *Ovis aries*; análise sensorial; *longissimus dorsi*; análise instrumental.

INTRODUCTION

Sheep rearing is a profitable alternative for Brazilian agribusiness, capable of increasing the profitability of farms in several regions because of the increasing demand for sheep meat and the adequate conditions for the country to expand production.

In Rio Grande do Sul, natural pastures are the main forage resource for sheep farming (Sebrae/Senar/Farsul, 2005). The natural pastures of the Pampa Biome, which covers the southern half of the state, feed a large part of the cattle and sheep populations raised extensively due to the productive potential of these pastures and great floristic diversity (Boldrini, 1997).

The sheep herd of the Pampa Biome region is formed by wool and/or dual purpose breeds, among which Corriedale sheep are the most representative. Natural colored sheep, which may appear in all breeds spontaneously, are becoming an alternative of production and income for the sheep farming as it can add greater value to by-products. Thus, the natural colored sheep production has potential for expansion due to the increasing demand for natural products, enabling sustainable production with low environmental impact.

A number of studies have confirmed the potential of Corriedales to produce high quality meat in Rio Grande do Sul (Macedo *et al.*, 2000; Azeredo *et al.*, 2005; Osório *et al.*, 2005; Rota *et al.*, 2006; Jardim *et al.*, 2007; Costa *et al.*, 2009; Osório *et al.*, 2013). However, there is little information on the influence of the genetic alterations that determine the appearance of dark pigmented wool fibers in Corriedales (Rota *et al.*, 2007; Costa *et al.*, 2009; Osório *et al.*, 2009) on meat quality.

The last decade was characterized by important changes in the eating habits of meat consumers (Hoffman *et al.*, 2003). According to Costa *et al.* (2008), the demand for healthier foods and higher quality products drove part of the market to consume meats with better nutritional and sensory quality.

Several factors interfere in sheep meat quality, and according to Osório *et al.* (2013), they can be classified as intrinsic (species, breed, sex and age) and extrinsic (nutrition, environment and pre- and post-slaughter handling) to the animal. These factors affect the tissue and biochemical structure of the muscle, acting on the sensory and technological attributes of the meat (Teixeira *et al.*, 2010).

Gomes *et al.* (2013) identifies appearance, softness, juiciness and taste as the main factors that influence the reaction of whether or not to like a particular portion of meat; these attributes are directly influenced by the animal's age, sex, breed and feeding system. In this way, meat sensory evaluation allows us to know the consumer market's preference and, consequently, to establish the quality of the product that provides a greater degree of satisfaction.

However, few studies characterize the instrumental and sensory attributes of sheep meat in Brazil, and this lack of information is more pronounced when considering natural colored sheep. Thus, the objective of this work was to investigate the effect of the sheep genetic group on instrumental and sensory characteristics of natural colored and white Corriedale lamb meat.

MATERIAL AND METHODS

The experiment was carried out in a private farm in the municipality of Dom Pedrito, in the region of Campanha, Rio Grande do Sul, located between the coordinates 30°15'28" and 31°49'12" south latitude and 53°28'08" and 53°31'58" west longitude, in natural pastures of the Pampa Biome. A total of 29 Corriedale lambs from two genetic groups [13 natural colored (NC) and 16 white (WH)] with average age of 18 months were used in the experiment. The lambs used in the study came from the mating of Corriedale sheep in the respective groups, that is, white lambs from the mating of white Corriedales with white Corriedales and natural colored lambs from the mating of

natural colored Corriedales with natural colored Corriedales.

The lambs were born between August and September 2009 and raised in improved native pasture containing ryegrass (*Lolium multiflorum*), birdsfoot trefoil (*Lotus corniculatus*) and white clover (*Trifolium repens*).

The slaughter was carried out when the lambs reached a minimum weight of 40 kg and individual body condition scores between 3.0 and 3.5 in a refrigerated slaughterhouse under state inspection, according to the humane handling regulations established by CISPOA (Coordination of Industrial and Sanitary Inspection of Animal Products) of the state of Rio Grande do Sul.

The pH was measured immediately *post-mortem* in the *longissimus dorsi* muscle, between the 12th and 13th ribs, using a Marte MB 10 pH-meter with penetration electrode, as described by Osório & Osório (2005). Carcasses were stored in a cold chamber at average temperature of 1 °C with forced air. After a chilling period of 18 hours, carcasses were removed from the chamber and split longitudinally, at midline.

The half-carcasses were sectioned between the 12th and 13th ribs and the subjective characteristics (texture, marbling and color) were evaluated on the surface of the *longissimus dorsi* muscle (Osório & Osório, 2005).

The pH was measured again 24 hours *post mortem* in the *longissimus dorsi* muscle, which was excised from the carcass, packed, and frozen at -18 °C for further sensory and instrumental analysis.

Instrumental and sensory analyzes of meat were carried out at the Carcasses and Meats Laboratory of the Department of Animal Science - FAEM - Federal University of Pelotas.

The samples of the *longissimus dorsi* muscle were thawed at 4 °C for 24 h for the instrumental analyzes (physical-chemical). Color determination was performed with a Chroma Meter CR-310 colorimeter (Minolta, Osaka, Japan), using the L*, a*, b* coordinates, where L* (lightness), a* (intensity of the red color) and b* (intensity of the yellow color). The analysis of water holding capacity (WHC) was carried out with the pressure method (Sierra, 1973). The resulting meat sample was weighed again on a digital scale to determine the lost water. The result was expressed as the amount of water retained in relation to the initial weight of the sample.

The sensory analysis was performed in four sessions with nine trained panelists, according to Meilgaard *et al.* (1999), evaluating 14 replicates of each of the two treatments. The samples were thawed at 4 °C for 24 hours, wrapped in aluminum foil and placed on a preheated electric grill (Black & Decker, GS 1600, Brazil) until reaching the internal temperature of 75 °C measured with a penetration thermometer. Then, the samples were cut

parallel to the muscle fibers into 1.5 cm cubes, coded with three-digit numbers and served at a temperature of 60 °C. The samples were analyzed in individual booths and evaluated according to the following attributes: color intensity, characteristic odor, fat odor, characteristic taste, fat taste, hardness, fibrousness, juiciness and the overall acceptance by hedonic test using a structured scale of 9 cm, anchored to the left by the term 'weak' and to the right by the term 'strong' (Stone & Sidel, 1998).

The experiment was arranged in a completely randomized design. The analysis of variance examined the effect of the genetic group (NC or WH) and the means were compared by the F test using the statistical program SAS (2001), with 5% significance level. The statistical model used was: $Y_{ij} = \mu + S_i + \epsilon_{ij}$, where: Y_{ij} = Variable studied; μ = Mean overall; S_i = effect of the genetic group; i (1 = NC and 2 = WH); ϵ_{ij} = Experimental error.

In the model described above, the following variables were considered as dependent variables: 0h pH (measured immediately *post-mortem*), 24h pH (measured 24 hours *post-mortem*), fat cover thickness (FCT), marbling, texture, water holding capacity (WHC), color, lightness, a* red content, b* yellow content, characteristic odor and taste, fat odor and taste, hardness, fibrousness, juiciness and overall acceptance; and as independent variable: natural colored or white lambs.

RESULTS AND DISCUSSION

There was no significant difference for 0h pH between the different genetic groups ($p > 0.05$). However, higher values of 24h pH were found for natural colored carcasses ($p < 0.05$) (Table 1).

However, Silva Sobrinho *et al.* (2005b) found no differences for 24h pH among the genotypes Romney, East Friesian x (Finn x Texel) and Finn x Poll Dorset, with mean value of 5.59 for the three genotypes evaluated.

The mean values found for 24h pH in NC lambs are consistent with those of Silva Sobrinho *et al.* (2005a) and Bonacina *et al.* (2011) who studied lambs Ideal x Ile de France and Texel x Corriedale, respectively. However, these values are in the lower limit of the range considered as normal for 24h pH in the literature, since, Young *et al.* (2004) argues that the final pH considered normal varies in the range of 5.4-5.6. According to this scale, the 24h pH of WH lambs can be considered low, but apparently it caused no reduction in meat quality of these animals. In addition, as noted by Sañudo (2004), there is a trend for the final pH to become lower with increasing age. As the lambs used in this study were on average 18 months old, it is assumed that the final pH was reduced due to their older age.

There were significant differences in fat cover thickness (FCT), with NC lambs having fatter carcasses ($p < 0.05$).

WH lambs had mean FCT similar to that found by Macedo *et al.* (2000): 1.36 cm for lambs of the same breed and color finished in Bermuda grass (*Cynodon dactylon*). NC lambs had thicker FCT, which may indicate that this genetic group has better ability for fat deposition.

There were no significant differences in the degree of meat marbling between the different groups ($p > 0.05$). The mean marbling value of the carcasses was higher than that found by Rota *et al.* (2004), which was 1.32 for Texel \times Corriedale male lambs raised in natural pasture with concentrate supplementation. This result can be considered normal, since the crossing of the breed Corriedale with a meat-type breed is expected to produce leaner carcasses.

In the texture evaluation, the objective analysis showed that NC lambs had slightly thinner fibers than WH lambs ($p < 0.05$). Texture consists of a bundle of muscle fibers grouped in fascicles enveloped by a layer of connective tissue (perimysium) and evaluated subjectively by the granulation of the muscle surface when being cut (Restle *et al.*, 2002). A thin texture, which indicates a smaller diameter of the muscular fibers, gives a better appearance and indicates that the meat comes from a young animal and is therefore softer (Osório & Osório, 2005). However, in sheep, this trend is not always confirmed. Rota *et al.* (2006) evaluated subjectively the meat texture in lambs of 4, 7 and 12 months of age and found no differences among them. But Gularte *et al.* (2000) studied 7-, 8- and 9-month-old Corriedale lambs and found higher scores for meat texture of 7-month-old sheep. Because the lambs used in the present study had similar ages at slaughter, the differences observed in meat texture could be attributed to a greater accumulation of connective tissue in WH lambs.

No significant differences were observed between the genotypes ($p > 0.05$) for water holding capacity (WHC). However, the values of WHC found in this study were lower than those reported by other published studies (Rota

et al., 2004; Bonacina *et al.*, 2011), which may be related to the pH found, since the variations in water holding capacity are related to the rate of pH reduction during *rigor mortis* and its final value; the greater the pH, the greater the capacity to retain water (Lawrie, 2005).

Color plays an important role on meat sensory quality and stands out as the main factor of appreciation at the time of purchase (Costa *et al.*, 2008). Meat from natural colored animals was classified as darker ($p < 0.05$) by both the colorimeter and the panel analysis (Table 2).

According to Silva Sobrinho *et al.* (2005b), muscle color is determined by the amount of myoglobin and the relative proportions of this pigment. Osório *et al.* (2009) discuss that pH influences the stability of sheep meat color, and one should consider the final pH at *rigor mortis* and its drop during *pre-rigor*, since meats with high pHs have darker color due to greater light absorption. Dhanda *et al.* (2003) argue that the genetic factor can influence meat color by the deposition of pigments in muscle or adipose tissue. It seems possible that the darker color in the meat of natural colored lambs is due to higher values of 24h pH and genetic factors.

Although there were no significant differences between the groups for the variables L^* , a^* , and b^* , the meat of NC and WH Corriedale lambs was redder than that of Santa Inês sheep (Madruga *et al.*, 2005), whose mean values were L^* (39.76 to 42.96), a^* (12.81 to 14.22) and b^* (9.04 to 10.16).

No significant differences ($p > 0.05$) were found for the parameters characteristic odor and fat odor, although NC animals had slightly higher values of these attributes.

The panelists identified that meat from NC lambs had a more pronounced characteristic taste and fat taste ($p < 0.05$) than meat from WH lambs, which was already expected because NC lambs showed higher values of FCT ($p > 0.05$) and because the characteristic taste of sheep meat is

Table 1: Means and standard errors for the physical-chemical characteristics of meat of natural colored (NC) and white (WH) lambs

Parameter ⁽¹⁾	Genetic Group		F Test
	NC	WH	
0h pH	6.37 \pm 0.1	6.19 \pm 0.1	0.2739 ns
24h pH	5.43 \pm 0.1	5.09 \pm 0.1	0.0192 *
FCT	2.07 \pm 0.3	1.31 \pm 0.1	0.0092 **
Texture	2.73 \pm 0.2	2.25 \pm 0.1	0.0371 *
Color	3.11 \pm 0.1	2.34 \pm 0.1	0.0009 **
Marbling	1.53 \pm 0.2	2.06 \pm 0.2	0.0980 ns
L	41.27 \pm 0.8	42.44 \pm 0.8	0.3096 ns
a^*	15.84 \pm 0.5	14.4 \pm 0.5	0.0567 ns
b^*	10.39 \pm 0.7	9.34 \pm 0.6	0.2690 ns
WHC	3.88 \pm 0.1	3.90 \pm 0.1	0.6989 ns

ns Non-significant. ** Significant at 1% probability. * Significant at 5% probability.

⁽¹⁾ FCT, fat cover thickness; L, brightness; a, red content; b, yellow content; WHC, water holding capacity.

directly related to the fat content in the muscle (Osório *et al.*, 2009). Madruga *et al.* (2005) studied the meat quality of Santa Inês lambs finished with different diets and also found that the meat with greater fat content had more intense characteristic taste of sheep meat.

No significant difference was detected for the attributes hardness, juiciness and fibrousness ($p > 0.05$). The mean values for hardness were similar to those found by Bonacina *et al.* (2011), mean of 3.75 for Texel x Corriedale lambs finished in pasture.

Although some sensory characteristics showed significant differences between the groups, no differences

($p > 0.05$) were observed for the overall acceptance of the samples, confirming that the genetic group has no effect on the preference of trained panelists.

The overall acceptance values are considered low (Table 2), probably because some of the panelists do not consume sheep meat frequently, thus being unfamiliar with the product. This result agrees the finding of Font I Furnols *et al.* (2006), who studied the acceptance of lamb meat by consumers in different European countries and concluded that one of the factors influencing meat acceptance is the eating habit.

Table 2: Means and standard errors of the sensory analysis of meat of natural colored (NC) and white (WH) lambs

Parameter ⁽¹⁾	Genetic Group		F Test
	NC	WH	
Color	4.78 ± 0.1	3.92 ± 0.1	0.0001 **
Characteristic odor	4.60 ± 0.1	4.40 ± 0.1	0.2901 ns
Fat odor	3.78 ± 0.2	3.46 ± 0.1	0.1201 ns
Characteristic taste	4.96 ± 0.1	4.51 ± 0.1	0.0302 *
Fat taste	3.67 ± 0.1	3.17 ± 0.1	0.0137 *
Hardness	3.91 ± 0.1	3.7 ± 0.1	0.1926 ns
Juiciness	3.33 ± 0.1	3.16 ± 0.1	0.3908 ns
Fibrousness	3.52 ± 0.1	3.91 ± 0.1	0.0621 ns
Overall acceptance	4.09 ± 0.1	3.74 ± 0.1	0.0901 ns

^{ns} Non-significant. ****** Significant at 1% probability. ***** Significant at 5% probability.

CONCLUSIONS

Natural colored Corriedale lambs have darker meat with higher texture values, pH measured 24 hours *post mortem*, fat cover score and more intense fat taste and characteristic taste of sheep. The genetic group has no effect on the acceptance of the Corriedale lamb meat by the panelists.

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