COLOR, pH, DRIP LOSS, OXIDATIVE PARAMETERS AND MINERAL CONTENT IN URUGUAYAN *CRIOLLO* LAMB MEAT

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Abstract- Muscles *Longissimus dorsi*, *Psoas major* and *Gluteus medius*, from six *criollos* lambs, were evaluated for pH, color, drip loss, lipid and protein oxidation, heme and non heme iron content after 0, 14 and 21 days of ag ing. Also, mineral content as, Se, Cu, Mn and Mo were measured in unaged meat. Results showed that pH values was not affected by muscle or aging, whereas *L, *a** and *b** color parameters, and drip loss was slightly higher with the aging time. TBARS increased with aging in all muscles. Carbonyls, heme and non heme iron was not affected by aging nor difference was observed between muscles. Se content was more elevated in *Gluteus medius* muscles, while Cu, Mn and Mo content were not different. In conclusion, meat from *Criollo* lamb showed interesting technological and nutritional parameters to place it as a promising meat product in the local and regional market.**

I. INTRODUCTION

The *Criollo* sheep is a local breed that has been adapted to the environmental conditions of Uruguay since more than four centuries. Currently, the *Criollo* sheep is found in small flocks that are raised by farmers in low-value pastoral fields (1). Through these animals, producers maintain a form of traditional breeding transmitted generationally (2). His meat is highly appreciated locally, consumed within the rural setting or is sold in small local circuits. The study of the technological and nutritional qualities of this kind of meat is necessary to obtain information for a better understanding of this differential product. The obtained information will help producers to promote their production locally and regionally. That also will help the conservation of a genetic group that is endangered in Uruguay. This is the first time than the technological and nutritional parameters of *Criollo* meat were investigated for the breed present in Uruguay. So, the aim of the present work was the determination of pH, color, drip loss, lipid and protein oxidation, heme and non heme iron content after 0, 14 and 21 days of aging. Also, mineral content as, Se, Cu, Mn and Mo were measured in unaged meat.

II. MATERIALS AND METHODS

Six *Criollo* lamb males, weighting 24.75±1.03 kg were selected in a farm in the Rocha 'region of Uruguay and transported to a commercial authorized abattoir, where they remained overnight (approximately 12 h) in the lairage pens with cemented walls and non-skid floors. Water was freely available but there was no access to feed. All the followed procedure were in accord to the official rules for transport, sacrifice and dressing of lamb in Uruguay, and special recommendation for handling this kind of animals (3). The research protocol has been approved by the Animal Experimentation Ethics Committee of the University of the Republic (Udelar). After dressing, the carcasses entered a freezing tunnel that led to a chill room at 2–3 °C, with an air velocity of 0.5 m/s, until 24 h post-mortem. Cold carcass weight (average 11.45 ±2.34 kg) .was taken after 24 h in the cold room. After chilling for 24 h, the right *Longissimus dorsi* (LD), *Psoas major* (PM) and *Gluteus medius* (GM) muscle were removed, and each one was divided into three sections. One is considered as unaged and the two others were vacuum-packaged and aged for 14 and 21 days, respectively, at 2 ° C. In unaged and aged samples the following measures were realized. pH was measured using a penetration Ph-meter LT Lutron pH-201. Color was measured using a portable CR-10 Minolta colorimeter, based on the CIE L*a*b* system. For all samples, the measures were carried up after 30 min of bloom at 3 °C. Drip loss was measured by the determination of the weight difference with 2.5 g of meat

samples (4). Lipid oxidation was determined by TBARS method (5) with some modifications (6). Protein oxidation was estimated by the reactions between carbonyls and (*2,4*-dinitrophenylhydrazine) with the resulting formation of a Schiff base which produces hydrazone, quantified by spectrophotometer at 360 to 385 nm (6). The determination was carried out by the method of Mercier et al. (7). Heme iron was measured by method proposed by Hornsey (8) adapted by Ramos et al., (9). Non heme iron was analyzed by the Ferrozine method described by Ahn et al. .Se, Cu, Mn and Mo were measured according to Cabrera et al. (10) using an atomic absorption spectrophotometer with graphite furnace (Analyst 300, Perkin Elmer, USA)

III. RESULTATS AND DISCUSSION

Results about the technological characteristics are presented in Table 1. No muscle main effect was observed for color, pH and drip loss ($p>0.05$). An aging main effect was observed for color, L*, a*, b* ($p<0.001$). Lightness, redness and yellowness significantly increased with aging time. This effect was previously observed in aged vacuum- packaged lamb meat (11). pH values were under 6 for LD and GM, but PM showed pH higher 6. This differences were not significant between muscles (Table 1). The drip loss significantly increased with aging ($p<0.001$) but no difference was observed between muscles. For the oxidative parameters, lipid oxidation increased with the aging time, but no effect for muscles was observed (Table 2). Protein oxidation, were stable along the aging this results are indicative of a lower protein degradation principally the myoglobin (11). Heme and non heme iron were also stable during the aging time. For mineral content in unaged meat (Table 3), Se content but not Cu, Mn and Mo, showed a muscle effect. Indeed, GM has a significantly higher content of Se than LD or PM.

IV. CONCLUSION

Meat from *Criollo* lamb produced in Uruguay showed some interesting technological and nutritional parameters to place it as a promising meat product in the local and regional market. Indeed, this study, the first in the country, contributes to a better knowledge of meat quality of lamb carcasses from *Criollo* breed and provides data on the oxidative stability and mineral composition of this kind of meat

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Table 1. Color (L, a*, b*), pH and drip loss (%) in unaged and aged *Longissimus dorsi (LD), Psoas major (PM)* and *Gluteus medius (GM)* muscles from *Criollo* lambs.

	Days of aging								
	0	14	21	0	14	21	0	14	21
		LD			PM			GM	
L*	33.8 ±0.9	35.5 ±1.0	37.2 ±1.0	37.2 ±0.7	39.0 ±0.8	40.9 ±0.8	37.4 ±1.2	39.3 ±1.2	41.1 ±1.3
a*	18.7 ±1.1	19.6 ±1.1	20.5 ±1.2	18.0 ±0.8	19.0 ±0.8	19.9 ±0.9	19.7 ±0.5	20.7 ±0.6	21.7 ±0.6
b*	7.95 ±0.46	8.35 ±0.48	8.76 ±0.50	8.30 ±0.63	8.70 ±0.66	9.20 ±0.69	9.75 ±0.5	10.25 ±0.6	10.75 ±0.6
pH	5.77 ±0.04	5.75 ±0.04	5.75 ±0.03	6.07 ±0.1	5.88 ±0.2	6.05 ±0.1	5.84 ±0.05	5.80 ±0.04	5.82 ±0.05
Drip loss %	3.1 ±0.2	6.2 ±0.3	7.8 ±0.4	3.0 ±0.3	6.0 ±0.6	7.6 ±0.8	3.0 ±0.3	6.0 ±0.6	7.5 ±0.8
	Mains effects								
	L*, a*, b*, drip loss: Muscle ns Aging P < 0.001						pH: Muscle Ns Aging Ns		

Data are mean ± SEM. Mains effects for muscle and days of aging were analyzed by repeated measures ANOVA and post hoc Tukey test (P < 0.05) (NCSS, 2007). Ns= No significant.

Table 2. Lipids and protein oxidation, and heme and no heme iron content in unaged and aged *Longissimus dorsi, Psoas major* and *Gluteus medius* muscles from *Criollo* lambs.

	Days *post mortem*								
	0	14	21	0	14	21	0	14	21
	Muscles								
	Longissimus dorsi			*Psoas major*			*Gluteus medius*		
TBARS (mg MDA/ kg meat	0.64± 0.03	0.74± 0.18	0.90± 0.12	0.58± 0.04	0.71± 0.12	0.93± 0.11	0.52± 0.04	0.97± 0.09	0.96± 0.13
Carbonyl (nM NADPH/ mg prot)	0.50± 0.07	0.44± 0.05	0.39± 0.02	0.55± 0.09	0.54± 0.04	0.39± 0.04	0.43± 0.02	0.43± 0.05	0.44± 0.03
Heme iron (ppm)	16± 0.6	15.2± 1.0	14.9± 1.0	16.2± 1.2	16.3± 1.8	16.9± 0.8	16.3± 0.7	16.9± 1.3	16.4± 0.6
No heme iron (ppm)	0,63± 0,09	0,55± 0,09	0,55± 0,04	0,54± 0,08a	0,53± 0,02a	0,86± 0,08b	0,74± 0,07	0,65± 0,06	0,59± 0,08
	Mains effects								
	TBARS (mg MDA/kg meat						Muscle: Ns	Aging: P<0.001	
	Carbonyl (nM NADPH/mg prot						Muscle: Ns	Aging: Ns	
	Heme iron (ppm)						Muscle: Ns	Aging: Ns	
	No heme iron (ppm)						Muscle: Ns	Aging :Ns	

Data are mean ± SEM. Main effects for muscle and days of aging were analyzed by Repeated measures ANOVA and post hoc Tukey test (P < 0.05). Within the same muscles, different letters mean significant differences (P < 0.05) for aging duration. Ns=No significant.

Table 3. Minerals content in unaged *Longissimus dorsi* (LD), *Psoas major* (PM) and *Gluteus medius* (GM) muscles of *Criollo* lambs.

	Muscles			
	LD	PM	GM	Significance
Se (mg/kg)	0.261±0.03b	0.234±0.03b	0.415±0.08a	P < 0.05
Cu (mg/kg)	1.08 ± 0.16	1.38 ± 0.08	1.10 ± 0.08	Ns
Mn (µg/kg)	85.4 ± 7.4	98.7 ± 5	82.1 ± 5.9	Ns
Mo (µg/kg)	4.8 ± 1	4.8 ± 0.5	4.4 ± 0.7	Ns

Data are mean ± SEM. Different lowercase letters means a statistical difference by ANOVA one way and Tukey´s test (P < 0.05). Ns= No significant.