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Qualitative Characteristics of Meat from Lambs Fed Hydrolyzed Sugarcane

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***Abstract*—**We used 24 Ile de France lambs, weighing between 15 and 32 kg (BW). Treatments were supplemented with concentrate: "in nature" sugarcane (IN), sugarcane hydrolyzed using 0.6% calcium oxide (CaO) under aerobic condition (AER), and sugarcane hydrolyzed using 0.6% CaO under anaerobic condition (ANA), constituting a completely randomized design with eight repetitions per treatment. Lambs were housed in individual stalls and fed into the through, allowing 10% of leftovers. Lambs were slaughtered when body weight reached 32 kg. The following parameters were determined on *Longissimu lumborum* muscle of hot and cold carcasses: pH and color, 45 minutes and 24 hours after slaughtering. Qualitative analysis of the meat were performed in the loins, water-holding capacity (WHC), cooking loss (CL), and shear force (SF). We used a completely randomized design with three treatments and eight repetitions. Means were compared by Tukey test at 5% significance. A higher value for redness (a*) 45 minutes after slaughter (10.48) were found for lambs fed hydrolyzed under anaerobic conditions sugarcane. The other qualitative characteristics of meat were not affected by treatments (P >0.05). The comparison of meat quality resulting from the treatments shows that it is possible to feed *in nature* sugarcane to lambs, thus waiving hydrolyses process and the spending with alkalizing agent.

***Keywords*—**Calcium oxide, hydrolysis, meat quality, pH.

I. Introduction

DUE to competitiveness of today's market, companies have been using quality as a selling point to expand product market [1]. Qualitative analysis commonly performed in meat are, water-retention capacity (WRC), the losses in nutritional value losses through the released exudates, resulting in dry or tough meat; cooking loss (CL), the water loss during the cooking of the meat; shear force (SF), is the degree of force applied on the meat during mastication; pH, important quality parameter as it can affect other qualitative parameters, and meat color, it is related to its acceptability by the consumers [1]-[3].

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In the diet of ruminants, concentrates are more expensive compared to forage feeds [4]. Sugarcane is a tropical grass, able to produce high quantities of natural material and energy per unit area, while maintaining productivity during periods when forage is scarcest. However, it has limitations such as, low crude protein content (CP), from 2 to 4%; high content of non-degradable fiber, slow ruminal fiber and low mineral content.

Diets containing sugarcane need to be corrected with protein and mineral supplements of good quality [5].

Alkaline hydrolyzes has been used in order to reduce fiber levels and increase the consumption by ruminants. It also enables its storage for few days while minimizing costs with work hours.

The application of CaO in the sugarcane raises pH and after aerobic exposure decreases it. This occurs linearly, but it is not interesting, because the drop in pH occurs by action of microorganisms. They consume the soluble carbohydrates and cause acidification of sugarcane, thus aerobic stability of sugarcane decreases [6]. Theoretically, in sugarcane hydrolyzes under anaerobic conditions, without oxygen exposure, pH decreases more gradually over time compared to aerobic hydrolyzes, this may result in an environment less favorable for the development of aerobic microorganisms, such as yeasts. This study aimed to assess the quality of lamb meat fed *in nature* or hydrolyzed sugarcane with CaO under both, aerobic and anaerobic conditions.

II. Materials and Methods

The experiment was conducted at the Ovine Section, College of Agricultural and Veterinarian Sciences, São Paulo State University, Jaboticabal, SP, Brazil. We used 24 Ile de France lamb, not neutered, housed in individual stalls weighing between 15 and 32 kg. The design was completely randomized with the following treatments: IN, *in nature* sugarcane + concentrate; AER, sugarcane hydrolyzed using 0.6% CaO in aerobic conditiont + concentrate; and ANA, sugarcane hydrolyzed using 0.6% CaO in anaerobic condition + concentrate.

The diets were formulated to lamb weight gain was 250 g/day following the requirements recommended by [7]. The diets were 22% CP and 3.9 Mcal gross energy/kg DM and forage:concentrate ratio was 50:50. The variety of forage sugarcane used in the experiment was IAC 86-2480 with leaves, and chopped into particle size ranging from 1.0 to 2.5 cm. The alkalizing agent contained 93.37% CaO.

Feed was supplied daily at 8 a.m. and 5 p.m., to allow 10% of leftovers. At 32 kg body weight, the lambs were fastened of

solid food by 16 hours, subsequently stunned by a 250 V electric shock during 2 seconds followed by bleeding and evisceration. In the *Longissimus lumborum* muscles of the hot and cold carcasses we measured, pH and color 45 minutes after slaughtering, using a digital TESTO 205 pHmeter, equipped with penetration electrode and a Minolta CR-200 (*illuminant D65*) colorimeter, which determined L* (lightness), a* (redness), and b* (yellowness).

TABLE I
QUALITATIVE PARAMETERS OF *LONGISSIMUS LUMBORUM* MUSCLE OF LAMBS FED SUGARCANE UNDER DIFFERENT CONDITIONS

	Treatment			P	CV (%)
Variable	IN	AER	ANA		
pH (45 minutes)	6.65	6.70	6.52	0.53	4.60
pH (24 hours)	5.69	5.58	5.59	0.35	2.66
Color (45 minutes)					
L*	34.04	32.95	33.67	0.58	5.71
a*	8.52b	9.84ab	10.48a	0.04	13.23
b*	-1.38	-1.65	-1.16	0.19	34.85
Color (24 hours)					
L*	40.26	40.03	38.31	0.44	7.59
a*	11.85	12.04	12.43	0.83	14.69
b*	1.09	1.39	1.16	0.38	31.08
WRC, %	57.08	57.09	55.83	0.89	21.13
CL, %	43.51	42.94	42.52	0.94	11.37
SF, kgf/cm^2	3.12	2.51	3.09	0.06	10.03

IN = *in nature* sugarcane + concentrate; AER = hydrolyzed sugarcane with 0.6% CaO under aerobic conditions + concentrate; ANA = hydrolyzed sugarcane with 0.6% CaO under anaerobic conditions + concentrate. L* = lightness; a* = redness; b* = yellowness. WRC = water-retention capacity; CL = cooking loss; SF = shear force. Means followed by different letters in the rows, differ by Tukey (P<0.05).

The loins were vacuum packed and frozen at -18ºC for further qualitative analysis of the meat, when they were thawed at 10ºC in BOD incubator (type shelf-life) for 12 hours, with subsequent removal of the medial portion of the muscle. To determine WRC, meat samples of about 500 ± 20 mg were placed on a filter paper between two acrylic plates with a 10 kg weight on the top for 5 minutes. The resulting meat sample was then weighed and water loss was given by the difference between initial and final weight, that is, WRC = 100 – percent of water loss. Following methodology proposed by [1], meat samples were weighed and baked in an industrial oven preheated at 170ºC to determine CL. Internal temperature was controlled using a thermometer skewer type, when internal temperature reached 71ºC, the meat was taken from the oven, let to cool down to 25ºC and weighed again. Cooking loss was then calculated as a percentage. Shear force was determined on cooked meat samples cut transverse to the muscle fiber into rectangles with measures 3.0 cm x 1.0 cm x 1.0 cm using a *Warner-Bratzler* blade attached to the Texture Analyzer, and the values expressed as kgf/cm². Data were submitted to analysis of variance using the GLM procedure of software SAS 9.2 [8] at 5% significance. When significant differences were detected between treatments, means were compared by Tukey at the same significance level.

III. RESULTS AND DISCUSSION

The pH values of *Longissimus lumborum* (Table I) were not affected by treatments (P >0.05). In lamb meat, pH values higher than 5.8 are undesirable, since it indicates decreasing meat tenderness [9]. According to [10], pH changes from 6.56 to 6.69, 45 minutes after slaughter, and then again from 5.66 to 5.78, 24 hours after slaughter.

The pH values of lamb meat in this study were considered normal, with 15% reduction from 15 minutes (6.62) to 24 hours (5.62) after the slaughter, which characterizes the *rigor mortis* process, the change of muscle into meat [11]. This result corroborates [12] who while studying diet impact on lamb meat quality reported, after 24 h, pH of 5.57.

Lamb meat color ranges from 30.03 to 49.47; 8.24 to 23.53; and 3.38 to 11.10, for L*, a*, and b*, respectively, according to [13]. At 45 minutes after slaughter, a* in the *Longissimus lumborum* muscle was significantly higher (P <0.05) for lamb fed hydrolyzed sugarcane under anaerobic conditions (10.48), and lower for lamb fed *in nature* sugarcane (8.52). The a* value, 24 hours after slaughter, did not differ (P >0.05) among treatments (12.12). Overall, there was an increase in the intensity of meat redness (a*) and yellowness (b*) 24 hours after slaughter, due to the metabolic processes for converting muscle into meat.

A study of Merino sheep by [14] reports the values 39.70, 15.60 and 7.10 for meat quality parameters L*, a*, and b*, respectively. The amount of myoglobin varies according to gender, age and anatomical location, affecting meat color. With advancing age and higher carcass weight, the amount of pigment and red content (a*) also increase, and not always linearly, while lightness (L*) decreases [15]-[17].

Other qualitative characteristics of the meat were not significantly (P >0.05) different. Water-retention capacity was 56.65%, and this low value can promote considerable loss of moisture, which associated with low fat content may affect meat juiciness [18].

Cooking loss was 42.96%, slightly higher than the 38.90% reported by [19] when using the same methodology. Cooking loss is inversely proportional to WRC of the meat [20]. The SF of lamb meat hanged from 7.54 to 9.35 kgf and when measured in cm^2 varied between 2.51 and 3.12 kgf/cm^2. These values are considered appropriate to characterize this meat as tender to consumers. The low WRC implies loss of nutritive value due to exudates released, causing the meat to become drier and less tender [21]. The SF of lamb meat should be lower than 5 kgf [22] to be considered tender; however, consumer acceptance decreases when it exceeds 11 kgf [23]. The values obtained in this study are within the recommended for consumers and it is considered a tender meat.

IV. CONCLUSION

The comparison between *in nature* and sugarcane hydrolyzed using calcium oxide under aerobic and anaerobic conditions demonstrated that meat quality was not affected by either diet type.

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