MEAT QUALITY OF BEEF FROM NELLORE STEERS FED YERBA MATE SUPLEMENTED DIETS

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Abstract – This study aimed to evaluate meat quality from cattle fed diets supplemented with different levels of yerba mate (0%, 0.5%, 1%, and 1.5% w/w). Forty-eight Nellore steers with an average age of 21 months and an initial weight of 419 kg were individually fed during 94 days with the same base diet, differing only by yerba mate content. Diets were composed of corn silage and concentrate (60:40 w/w) with 11% crude protein and 72% of total digestible nutrients. Diets were balanced using 0%, 0.5%, 1.0 and 1.5% w/w of Kaolinite (kaolin), an inert ingredient. The experimental design was completely randomized with four treatments and twelve replications, with diet and aging time as a fixed factor. Color, pH, water holding capacity, cooking loss and shear force were measured at five different aging times (0, 7, 14, 21 and 28 days). The addition of yerba mate to the cattle diet affect luminosity (L*), cooking loss, and shear force parameters. However, addition of yerba mate to the cattle diet strong influenced all meat quality parameters during ageing.

Key Words – antioxidants, beef, *Ilex paraguariensis* St. Hilaire, shear force

I. INTRODUCTION

Oxidative processes in muscles tissues are important factors that directly affect meat quality. Oxidative reactions involving lipids are, along with microbial growth, the most frequent causes of food deterioration. Recently, protein oxidation is attracting increasing attention due to its relation to meat tenderness affecting consumer acceptance. The growing demand from the consumers for quality and safety meat products requires continuous adaptation of the production sector. Antioxidants are naturally occurring substances or may be intentionally added to food aiming to inhibit oxidation and maintain food sensory quality and safety. Currently, greater attention for replacing synthetic antioxidant and growth promoters by natural compounds is increasing in the feeding industry (1).

Recent studies have shown the potential use of natural antioxidants in the animal fed for improving animal performance, welfare, and meat quality. Meat from broilers fed with aqueous extract of yerba mate shown an increase in shelf-life stability due to a lower cholesterol level and better redox stability of the meat (2).

The aim of this study was to evaluate the effect of yerba mate supplementation in the diet of Nellore cattle finished on feedlot, in order to obtain meat with higher oxidative stability and sensory quality.

II. MATERIALS AND METHODS

Forty-eight Nellore steers were randomly assigned in individual pens and fed the same diet. The diets (Table 1) were differentiated only by the presence of different levels of yerba mate extract (0%, 0.5%, 1% and 1.5% w/w).

Table 1 - Composition of rations (% dry matter)

Ingredients	Treatments			
	1	2	3	4
Yerba mate extract	0	0,5	1	1,5
Kaolin	1,5	1	0,5	0
Corn silage	43	43	43	43
Ground corn grain	51,3	51,3	51,3	51,3
Soybean meal	1	1	1	1
Urea	1	1	1	1
Bicarbonate	1	1	1	1
Mineral supplement	1,2	1,2	1,2	1,2
Monensin	0,03	0,03	0,03	0,03
Nutrients (%)				
Crude protein	11	11	11	11
TDN	72	72	72	72

Animals were fed twice a day, during 94 days.
Then they were submitted to food and water fasting for 16 hours before slaughter, which was held in a commercial abattoir. Carcasses were chilled overnight at 2°C. At 24 hours post mortem, the left half-carcass was cut between the 12th and 13th rib where 2.5 cm steaks were removed for quality analyses (pH, color, water holding capacity, cooking loss and shear force) at the Embrapa Southeast Livestock Meat Analysis Laboratory. Steaks for aging were vacuum-packed and maintained at 1-2°C for 1, 7, 14, 21 and 28 days and analyzed for the same quality parameters.
For objective color, steaks were exposed to atmospheric air for thirty minutes prior to the analyses, and CIE L*, a* and b* parameters were measured at three different locations across the surface of the steaks using a Hunter Lab colorimeter model MiniScan XE. pH was then measured also at three different locations across the surface using a Testo pH measuring instrument, model 230. Water holding capacity was obtained by the difference between the weights of a meat sample of approximately 2g, before and after it was submitted to a pressure of 10 kgf for 5 minutes as described by Hamm (3).
For cooking loss and shear force measurements, the same steak of 2.5 cm thickness was weighed and cooked in a Tedesco combined oven, at 170°C until the temperature at the centre of the sample reached 70°C, controlled by a thermocouple using the FE-MUX software. Samples were then cooled at room temperature and weighed again. Cooking loss was calculated by difference between the weights before and after cooking, and expressed as percentage. Steaks were transferred to a cooler and held for 24 hours, after which, eight cores (1.27 cm in diameter) were removed per steak, parallel to the fiber grain. Peak shear force was determined on each core perpendicular to the fiber grain using a 1.016 mm Warner Bratzler probe in a TA.XT Plus Texture Analyzer (calibration weight 10kg). Full peak shear force was recorded and maximum shear force calculated as the average of the eight cores.
The experimental design was completely randomized with four treatments and twelve replications, with analysis of variance and regression depending on the levels of yerba mate added to the animal diet. The statistical model included the effect under study: diet and aging time. For statistical analysis, XLSTAT (4) software was employed.

III. RESULTS AND DISCUSSION

Significant differences among diets and ageing time as isolated effects were found ($p<0.05$). There were no interactions between these two factors. The different treatments affected luminosity (L*) ($p=0.008$), pH ($p=0.026$), cooking loss ($p=0.017$), and shear force ($P = 0.024$) as shown in Table 2.

Table 2 - Meat quality parameters, according to treatments

	Treatments				P value	SEM
	0%	0.5%	1%	1.5%		
L*	40.79^{a}	41.08^{a}	41.74^{b}	40.98^{a}	0.008	0.648
a*	17.78	17.94	17.88	18.11	0.512	0.49
b*	15.76	16.06	16.20	16.01	0,127	0,417
pH	5.36^{b}	5.32^{a}	5.35^{ab}	5.32^{ab}	0.026	0.034
WHC (%)	73.35	73.48	73.12	73.42	0.87	1.017
Cooking loss (%)	27.39^{ab}	26.44^{a}	28.11^{b}	27.18^{ab}	0.017	1.163
Shear force	4.41^{b}	3.92^{a}	4.08^{ab}	4.24^{ab}	0.024	0.367

WHC = water holding capacity
^{a,b,c,d} Means in the same row with different superscripts are significantly different ($P<0.05$)

The luminosity (L*) parameter was higher in samples of animals fed with 1% w/w of yerba mate extract. Values for this parameter ranged from 33.2 to 41.0, which are average values found for luminosity in beef (5). The animals used were castrated and showed meat with higher brightness compared to non-castrated animals, possibly due to the higher amount of intramuscular fat (6). Although pH values presented significant differences, they did not affect the results as they showed very close values. Higher values for cooking loss were

observed in animals fed with 1% w/w of yerba mate extract, and opposing values for cooking loss observed for meat from animals fed with 0.5% w/w yerba mate extract. No differences for cooking loss were observed as function of yerba mate supplementation. However, all cooking loss values are close to the values found in literature for Nellore beef cattle (6). Shear force showed higher values for meat from animals fed with the control diet. Even with a significant difference for mean value, meat from animal supplemented with yerba mate extract may be considered tender due to values lower than 4.5 kgf for shear force (7). Animals fed with 0.5% w/w extract of yerba mate showed the lowest shear force values compare to animals fed with higher levels of yerba mate.
According to the values presented in Table 3, all meat quality parameters showed significant differences (P <0.001) for different aging times.

Table 3 - Meat quality parameters, according to aging time

	Aging time (days)					SEM
	0	7	14	21	28	
L*	40.21^{a}	40.21^{a}	42.09^{c}	41.20^{b}	42.04^{c}	0.648
a*	14.71^{a}	17.49^{b}	18.43^{c}	19.64^{d}	19.35^{d}	0.49
b*	12.74^{a}	15.59^{b}	16.90^{c}	17.26^{cd}	17.55^{d}	0.417
pH	5.33^{b}	5.50^{d}	5.38^{c}	5.32^{b}	5.18^{a}	0.034
WHC (%)	76.75^{c}	72.98^{b}	71.72^{a}	73.06^{b}	72.21^{ab}	1.017
Cooking loss (%)	25.94^{ab}	25.03^{a}	26.42b	29.93^{c}	29.08^{c}	1.163
Shear force	7.72^{d}	4.29^{c}	3.18^{b}	3.39^{b}	2.22^{a}	0.367

P value < 0.001 for all parameters
WHC = water holding capacity
$^{a, b, c, d}$ Means in the same row with different superscripts are significantly different (P<0.05)

Luminosity (L*) showed increasing values with aging time. This behavior is expected due to the lower water holding capacity and reflection in the meat surface increases, turning the meat more clear (8). The reduction of the water holding capacity is a result of the decrease in the muscle pH changing the net charge of the myofibrillar proteins reducing their Coulombic repulsion resulting in lower water holding capacity (9). The a* color parameter increase during aging and may be related to the decrease in enzymatic activity turning oxygen more available to bind to deoxymyoglobin, thus enhancing bright-red colour (10). Changes in b* color parameter may be explained by the increase of metmyoglobin content due to oxidation of oxymyoglobin at the meat surface (10). As expected, post mortem ageing increased meat tenderness due to proteolytic activity, but interestingly meat from animals fed with yerba mate shown better tenderness after aging. This positive effect of yerba mate supplementation on the tenderness may be explained to improvement on the oxidative stability of the meat which results in a muscle tissue with higher activity of proteolytic enzymes that are well-known to be sensitive to oxidative stress.

In Figures 1 and 2, a PCA graph is presented

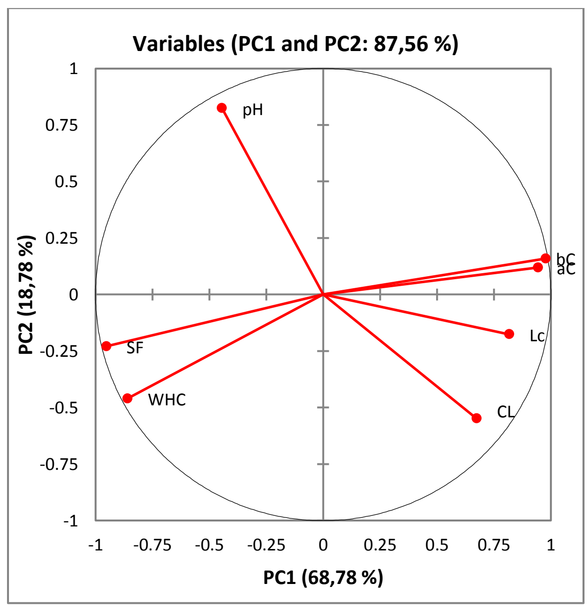

Fig. 1. Graph of principal component analysis

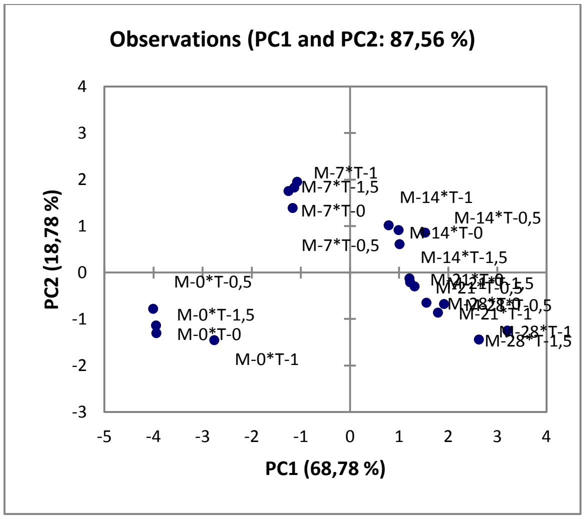

Fig. 2. Graph of principal component analysis

From the principal component analysis plots, it may be seen that 68.8% of the total variance among samples is explained by PC1. PC1 and PC2 account to 87.56% of the total variance. Ageing time provide a clear separation and clustering of samples in the PCA plot, but the differences among different traits were not so evident, except at time zero. The L *, a *, b * and CL parameters were positively related to 14, 21, 28 aging times. pH, SF, WHC were negatively related to 0 and 7 aging times.

IV. CONCLUSION

The addition of yerba mate extract to animal feed affected the meat characteristics of luminosity, cooking loss and shear force. Meat from animals fed with 0.5% w/w of yerba mate extract exhibit better quality parameters.

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