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MEAT QUALITY FROM GRAZING-BASED BEEF PRODUCTION SYSTEMS ON NATURAL GRASSLANDS OF PAMPA BIOME

Thais Devincenzi[1], Carlos Nabinger[1], Teresa Cristina Moraes Genro[2], Élen Nalério[2], Sérgio Juchem[2], Jean Kassio Fedrigo[1], Marcelo Fett Pinto[1]

[1] QuaPA UR 370, INRA, 63122 Saint Genes Champanelle, France

[2] UMRH, INRA, 63122 Saint Genes Champanelle, France

Abstract – Producing beef on natural grasslands may represent an alternative to local farmers to add value on meat products of Pampa Biome. However, the quality characteristics of these products must be investigated. In this sense, we investigated the meat quality of three grazing-based beef production systems in Pampa biome: Natural grassland (NG), Improved natural grassland (ING, fertilized and oversown with winter species) and Sorghum pasture (SP). From December, 2009 to November 30, 2010, we studied 43 Aberdeen Angus steers of about 18 months of age and 320 kg of body weight which were randomly distributed between treatments: NG (n=16); ING (n=18); SP (n=8). Animals were slaughter at 3 mm of fat thickness (FT). We evaluated steers performance and meat quality traits of beef. There were found perceptible differences on flavor and odor between the feeding systems. Beef from NG was tougher than that from SP, mostly because lower gains obtained on NG, however more desirable fatty acid profile was found for beef from animals grazing NG and ING.

Key Words – "aberdeen angus" "fatty acid profile" "South Brazilian rangelands"

I. INTRODUCTION

In Southern Brazil, livestock beef production still relies mainly on rangelands of Pampa Biome [1]. This biome is characterized by its herbage vegetation with a vast floristic biodiversity and consists in a natural pastoral ecosystem [2]. Besides their important ecological role, as conservancy of fauna diversity, water quality, sequestration of carbon, etc these rangelands are also associated with Gaucho´s culture.

The high diversity of forage species in this ecosystem also implies in more complex management of grasslands, which more and more leads farmers to choose monospecific pastures or even to change grasslands in croplands. This choice resulted in an estimated loss of about 440.000 ha of natural pastures per year in the last 10 years [3]. Beef production from natural grasslands can encourage farmers to maintain these areas as a resource to produce added-value beef. Meat products from Pampa Biome, which are also agreeing to the consumers claim for products that incorporate environmental conservancy. But, besides being "nature friendly", the meat product from natural grasslands must also supply the demands related to meat quality and nutritional composition. We aimed to investigate the quality of meat produced in three different grazing-based beef production systems based on natural grasslands on Pampa.

II. MATERIALS AND METHODS

The experiment was carried out between December, 2009 and November, 2010 in a particular farm located at Dom Pedrito district, at Rio Grande do Sul province, on the Brazilian portion of Pampa. Forty-two Aberdeen Angus steers of 18 months of age and about 320 kg of body weight (BW) were assigned to graze three different pastures i) Natural Grassland (NG; n=16), ii) Improved Natural (ING; fertilized and oversown with *Lolium multiflorum* and *Lotus corniculatus*, n=18) and iii) a monospecific Sorghum Pasture (SP; n=8). Each feeding system was characterized by its levels of inputs and the floristic composition of pastures. For NG and ING systems, animals were kept in continuous grazing with variable stocking rate aiming a forage allowance of 13 kg of dry matter per 100 kg of BW. On NG and ING systems, the average forage mass and height were respectively 1802 kg DM/ha and 8.9 cm. On SP system, animals were kept in a strip stocking. The animals started grazing when sorghum sward reached 90 cm height on average and the stocking rate was adjusted to demote the height until 30 cm in a one-week period. At the end of the fattening phase, the floristic composition was evaluated in the natural grasslands-based production systems (NG and ING) using Botanal method. Animals were slaughtered at 3 mm of subcutaneous fat measured with ultrasound at the 12th and 13th ribs. After 24 h of storage at 4°C, pH was measured and three samples of meat were taken out between the 12th and 13th rib. Two samples were 2.5 cm-thickness. The first was used for the determination of color, and Warner-Bratzler shear force (WBSF). The second was submitted to sensory tests. The third sample was cut in 1 cm-thick pieces and was used for fatty acid analysis. Full details of sample preparation were described by Devincenzi *et al*., [4]. For color measurements, meats were exposed to oxygen for 30 minutes and L* (lightness) a* (redness) and b* (yellowness) were determined according to CIE system, using a portable colorimeter (Chroma Meter Cr-400). For WBSF measurements, samples were cooked at 70°C in their geometric center and then chilled at room temperature. Seven cores (1.27 cm diameter) were cut from the cooked and chilled steaks parallel to the direction of the muscle fibers and the maximum shear force in kg/cm^2 was measured in a Warner-Bratzler cell with a 1.016-mm blade coupled in Texture Analyzer TA-500. For sensory test, samples were oven cooked at 70°C in their geometric center. Cubes of about 1.5 x 1.5 cm were served to eight trained assessors, for a duo-trio test performed in three replicates (ABNTNBR 13169, 1994) considering just odour and flavour. For lipid profile evaluation, the 1 cm-thick sample was minced and freeze dried and ground in liquid nitrogen to produce a fine and homogeneous powder from which lipids were extracted according to Bligh and Dyer method [5]. Fatty acids were esterified using Hartman & Lago [6] method. The fatty acids methyl esters were analyzed using a Shimadzu GC 2010 plus gas chromatograph with a capillary column with stationary phase of biscyanopropyl polysiloxane (RT-2560, 100m length, 0.25 mm internal diameter and 0.2µm film thickness) with H_2 as gas vector. Fatty acid methyl esters were identified by comparing the retention times with a standard (47885-U Supelco® 37 Component FAME Mix, vaccenic and conjugated linoleic acid-CLA standards). Retention times and areas were recorded and integrated by the software GC SOLUTION, V. 2.3. Results were expressed as a percentage of the total peak areas of the identified fatty acid methyl esters.

The experimental design was completely randomized with three feeding systems and a variable number of repetitions (NG n=16; ING n=18 and SP n=8). Data were underwent to Shapiro-Wilk test to verify their normality and then, were subjected to ANOVA using the total lipids content as a covariable and Tukey test at of 5% significance using the MIXED procedure of SAS, version 9.1.

III. RESULTS AND DISCUSSION

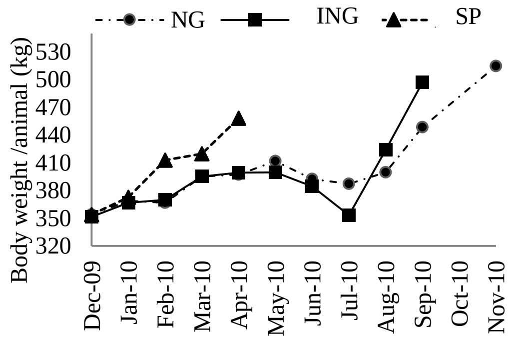
The five botanical species which had the highest contribution to the forage mass are shown on Table 1. Although *Lotus corniculattus* was spreadon ING treatment paddocks, its contribution to herbage mass was not representative and therefore is not shown on Table 1.

Table 1 The five most abundant botanical species and its contribution on total herbage mass (%) obtained by Botanal evaluation

Natural Grassland	Improved Natural Grassland
Coelorachis selloana (20.2%)	*Lolium multiflorum* (25.6%)
Paspalum notatum (14.1%)	*Paspalum notatum* (22.4%)
Paspalum dilatatum (9.05%)	*Piptochaetium stipoides* (13.9%)
Piptochaetium stipoides (8.6%)	*Axonopus affinis* (5.2%)
Botriochloa laguroides (7.1%)	*Paspalum ditatatum* (4.2%).

The lower growth rates of steers that grazed NG is a classical finding [7] (Figure 1). The slower forage growth and lower forage quality during the fall/winter season usually limits growth rates. The ING grazing steers also lost weight during this period, most likely due to the higher stocking rate from April to May. Increase in stocking rate was performed to reduce herbage mass and improve the establishment of the oversown winter species. Steers that grazed SP were slaughtered at younger age (p<0.001), presented lighter carcasses (P=0.003) and had higher carcass pH at 24h (P<0.001) than steers grazing NG and ING.

Figure 1 Development of Aberdeen Angus steers (kg of body weight/animal) finished in natural grassland (NG), Improved-natural grassland (ING) and annual summer grassland – sorghum (ASG)



The feeding system did not affected the fat thickness (FT) (P=0.40) as expected, since steers were slaughtered based on US back FT. For color evaluation on beef samples, although differences were found between treatments, all of them were considered in the normal range for beef. The samples showed lightness from intermediate to dark, high red values and high yellow values. The WBSF was higher in beef samples from NG grazing steers than for SP steers (P=0.056). It is important to underline that in our study the samples were not aged, so the WBSF value represents the basal value, which can be easily reduced by ageing treatments. Utilizing multiple regressions, ADG explained 18% of WBSF in beef. The differences observed for WBSF could be related to the higher body weight gain rates at the end of the fattening period, which could lead to a collagen turnover and therefore reduced the shear force of meat.

Table 2 Animal performance and meat quality of steers finished in three different feeding systems

	NG	ING	SP	P*	SE
Average daily gain (g/day)	0.466 b	0.491	0.833	<0.00	0.02
Cold carcass (kg)	246.6 a	249.4	218.7	0.003	3.18
Fat thickness (mm)	1.9	2.6	2.1	0.401	0.22
pH	5.67 b	5.61 b	5.85	<0.00	0.02
L*	35.3 ab	36.6 a	34.6	0.012	0.27
a*	23.3 a	23.7 a	21.2	0.007	0.31
b*	8.9 a	9.3 a	7.3 b	0.001	0.20
WBSF (kgf/cm²)	7.1 a	6.3 ab	5.5 b	0.056	0.25

*Probability

On sensory analysis performed by duo-trio test there were found perceptible differences on flavor and odor between the meat from the three feeding systems, obtaining 31 correct judgments in 48 trials (P<0.05).

There was no effect of the feeding systems on beef total lipid content (P=0.08; Table 3). The concentration of C16:0 and C14:0 in beef was slightly affected by grazing systems (P<0.05).

Overall, grazing natural forages during the finishing phase resulted in increased concentration of Linolenic acid in beef. Steers that grazed NG and ING pastures had 37 % more Linolenic acid than SP treatment.

There was no effect of the feeding systems on Conjugate Linoleic Acids (CLA) (P=0.087). The proportions of the long chain fatty acids (C22:2 *n*-6, C20:5 *n*-3, C22:5 *n*-3) were higher in beef produced from steers grazing NG and ING than in SP. Long chain fatty acids are formed on animal tissue from elongation reactions from C18:3*n*-3 and they are very desirable for human´s health aspect. Beef from animals finished grazing on SP showed higher concentration of saturated fat acid (SFA) than beef from ING treatment (P=0.023). The total polyunsaturated fatty acids (PUFA) proportions on beef were affected by the production systems (P=0.002). Overall, it was observed higher proportions of PUFA on beef produced from steers grazing NG and ING than SP. Higher levels of *n*-6 FA were found on beef from steers that grazed NG (P<0.001) as related to the higher proportion of C18:2*n*-6 found on beef from NG. The proportion of *n*-3 FA were higher on NG and ING than in SP beef (P=0.002). The *n*-6/*n*-3 ratio was lower on beef from ING treatment. All tested feeding systems resulted on desirable *n*-6/*n*-3 ratio according to the values described by Simopoulus, (2002).

Although these differences found in our study are too small to implicate in any nutritional consideration between treatments, is important to underline that even on grassland feeding systems we observed differences on fatty acid profile.

Table 3: Total fat content (TFC (%)) and fatty acid centesimal composition[1] (% of indentified total FAME[(1)]) on *Longissimus muscle* of steers finished in three different feeding systems

	NG	ING	SP	P*	SE
TFC	2.03	1.82	2.53	0.084	0.321
C14:0	1.48 b	1.40 b	1.75 a	0.007	0.099
C16:0	25.49 ab	24.62 b	26.35 a	0.004	0.416
C16:1	2.30	2.52	2.46	0.370	0.150
C18:0	18.72	18.10	19.20	0.491	0.823
C18:1t11	2.88	2.67	2.73	0.375	0.100
C18:1*n*-9c	38.37b	40.58a	38.73b	0.056	0.694
C18:1c11	1.34	1.43	1.26	0.087	0.040
C18:2*n*-6	2.95 a	2.31 b	2.05 b	0.001	0.158
C18:3*n*-3 (ALA[(2)])	0.93 a	0.99 a	0.70 b	0.010	0.042
CLA[(3)]	0.58	0.57	0.53	0.087	0.019
C20:4*n*-6	0.14 ab	0.15 a	0.10 b	0.044	0.015
C22:2*n*-6	0.11 ab	0.12 a	0.08 b	0.048	0.008
C20:5 *n*-3	0.48 a	0.49 a	0.33 b	0.050	0.032
C22:5*n*-3	0.80 a	0.80 a	0.55 b	0.005	0.048
SFA	47.38 ab	45.65 b	48.97 a	0.023	0.665
MUFA	46.25 b	48.59 a	46.34 b	0.039	0.723
PUFA	6.29 a	5.74 a	4.57 b	0.003	0.300
n-6	3.21 a	2.59 b	2.23 b	0.001	0.171
n-3	2.29 a	2.37 a	1.64 b	0.010	0.124
n-6/*n*-3	1.40 a	1.10 b	1.36 a	<.001	0.026
AI[(4)]	0.64 ab	0.58 b	0.66 a	0.002	0.018

*Probability
Means with unlike superscripts differ at the 5% probability level
SE= Standard Error
[(1)]FAME= Fatty acids methyl esters; g FAME/100 g FAME
[(2)]ALA= C18:3 *n*-3, 9c,12c,15c
[(3)] CLA = Conjugated linolenic acid (18:2 cis 9 trans 11)
[(4)] AI=(C12:0+4*C14:0+ C16:0)/(∑MUFA+∑n-6 +∑n-3)

IV. CONCLUSION

Besides presenting lower rates of animal performance, finishing systems based on natural grasslands or improved natural grasslands in Southern Brazil are more interesting from the point of view of meat quality and also from the environmental perspective than sorghum grasslands. Even more, the sensory evaluation indicates the possibility of obtaining a distinguish product at odour and flavour perspective.

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