EFECTS OF FEEDING MANAGEMENT ON TENDERNESS OF BEEF FROM NELLORE YOUNG BULLS

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Abstract – The aim of the present study was to evaluate the effect of feeding management on tenderness of beef from Nellore cattle. A total of 34 Nellore young bulls with 8.4 ± 0.3 months of age and 230 ± 5.6 kg of body weight were used. Animals were randomly assigned to the following experimental treatments: low body weight gain during the growing phase and high body weight gain during the finishing phase (LH; n=10), medium body weight gain during the growing phase and high body weight gain during the finishing phase (MH; n=12), and high gain in both growing and finishing phases (HH; n=12). At the end of the growing phase five animals from the LH and six animals from MH and HH treatments were slaughtered. The remaining animals were slaughtered at the end of the finishing phase. At the end of the growing phase differences were observed (P<0.05) for sarcomere length with the greatest value observed in muscle of animals from HH, the least value observed in muscle of animals from LH and intermediate values observed in muscle of animals from MH. No differences were observed among treatments for myofibrillar fragmentation index and shear-force at the end of the growing phase (P>0.05). Similarly, no effects of experimental treatments were observed (P>0.05) for meat quality traits at the end of the finishing phase. Our data suggests that the use of different feeding management during the growing phase to achieve continuous or compensatory growth does not affect quality traits of beef from Nellore cattle.

I. INTRODUCTION

The processes of synthesis and degradation of skeletal muscle proteins are responsible for growth, remodeling and turnover of muscle tissue. Changes in protein synthesis or degradation may affect the production efficiency and meat quality traits [1].

After animal slaughter, the protein synthesis is stopped while the myofibrillar degradation continuous to occur leading to a tenderization of meat [1]. Thus, it has been suggested that animals with high turnover rates prior to slaughter may produce more tender meat.

A higher activity of calpastatin is observed in muscle of *Bos taurus indicus* compared to *Bos taurus taurus* cattle, which inhibits calpain activity [2]. As such, use of feeding strategies to improve animal performance may enhance protein turnover, mainly when the animal express a compensatory gain. It has been reported that animals that had a compensatory growth produce tender beef [3].

Therefore, the objective of this study was to evaluate the effect of feeding strategy on tenderness of beef from Nellore young bulls.

II. MATERIALS AND METHODS

All animal care and handling procedures were approved by the Animal Care and Use Committee of the Department of Animal Science of the *Universidade Federal de Viçosa*, Brazil (protocol 90/2013).

A total of 34 Nellore young bulls averaging 8.4 ± 0.3 months of age and 230 ± 5.6 kg of body weight were used. Cattle were confined in collective pens with electronic head gate system. Animals were randomly assigned to the following experimental treatments: low body weight gain during the growing phase and high body weight gain during the finishing phase (LH; n=10), medium body weight gain during the growing phase and high body weight gain during the finishing phase (MH; n=12), and high gain in both growing and finishing phases (HH; n=12).

Initially, animals were submitted to a 24 d of adaptation to experimental conditions followed by 90 d of growing phase. At the end of the growing phase animals went through the transition phase (21 d for MH treatment, and 31 d for HH and LH treatments) followed by a 112 d of finishing phase.

To obtain the targeted body weight gains four diets were formulated: three for the growing phase and only one for the finishing phase as shown in Table 1.

Table 1. Composition of experimental diets.

Items	Growing phase			Finishing
	HH	MH	LH	
Sugarcane bagasse	-	-	-	16.13
Sugarcane silage[1]	36.94	60.23	80.68	-
Corn	44.63	22.58	8.42	57.73
Soybean meal	14.24	12.90	5.54	10.42
Whole cottonseed	-	-	-	11.68
Urea	1.07	1.10	2.06	1.00
Dicalcium phosphate	-	0.12	0.30	-
Commercial premix[2]	3.12	3.05	3.00	3.04

[1]Sugarcane silage with 0,5% of calcium oxide.
[2]Contained per kg: 150g of Ca, 17g of P, 23g of S, 45g of K, 14g of Mg, 57g of Na, 360mg of Cu, 21,6mg of Co, 415mg of Fe, 21mg of I, 715mg of Mn, 6mg of Se, 397g of CP (NPN) and 714mg of Sodium Monensin.

At the end of the growing phase, five animals from the LH and six animals from MH and HH treatments were slaughtered. The remaining animals were slaughtered at the end of the finishing phase.
After 24 h postmortem chill (4ºC) a boneless *Longissimus dorsi* sample was removed from the posterior end of the wholesale rib from the left half of each carcass. Samples were individually, vacuum packaged and frozen at -20ºC. Each frozen *Longissimus dorsi* sample was standardized into two 2.54 cm thick steak samples [4], one for Warner-Bratzler shear force (WBSF) measurement and sarcomere length and the other for determination of myofibrillar fragmentation index (MFI). All steaks were then vacuum packaged and held at -16ºC until analyses were performed.
WBSF steaks were thawed at 4ºC for 24 h and oven-broiled in an electric oven (Layr Luxo Inox, Jundiaí, SP) preheated to 150ºC. Internal steak temperatures were monitored by 20-gauge copper-constantan thermocouples (Omega Engineering, Stamford, CT) placed in the approximate geometric center of each steak and attached to a digital monitor. When internal steak temperature reached 35ºC, the steak was turned over and allowed to reach an internal temperature of 70ºC before removal from the oven. Cooked WBSF steaks were cooled for 24 h at 4ºC [4]. Eight round cores (1.27 cm diameter) were removed from each steak parallel to the long axis of the muscle fibers [4]. Each core was sheared once through the center, perpendicular to the fiber direction by a Warner-Bratzler shear machine (G-R Manufacturing Company, Manhattan, KS - USA).
Myofibrillar fragmentation index (MFI) were determined on fresh muscle according to the procedures described by Hopkins *et al.* [5]. The protein concentration of the myofibril suspension was determined by the biuret method. Aliquots of the myofibril suspension were diluted with an isolating medium to reach a protein concentration of 0.5 ± 0.05 mg/ml. The diluted myofibril suspension was stirred and poured into a cuvette; absorbance of this suspension was measured immediately at 540 nm. Absorbance was multiplied by 150 to give a MFI for each sample.
The same *Longissimus* muscle samples used for MFI measurements were used for evaluation of sarcomere length. Small cubes (3.0 x 3.0 x 2.0 cm) were excised in triplicate from each sample. Sarcomere length was measured by laser diffraction using a 05 – LHR – 021 laser, (Melles Griot, Carlsbad, CA) and calculated as described by Cross *et al.* [6]. From each cube, sarcomere length of six fiber samples was determined and used for sarcomere length average calculation
The experiment was performed in a completely randomized design. The response variables were analyzed using PROC MIXED in SAS 9.0 (Statistical Analysis System Institute, Inc., Cary, NC, USA). To evaluate effects of feeding managements on meat quality traits data were submitted to ANOVA and the least square means were compared using Tukey`s method at $\alpha = 0.05$.

III. RESULTS AND DISCUSSION

The average daily gain (ADG) during the growing phase differed ($P < 0.01$) among feeding managements and values of -0.06; 0.67; and 1.09 kg/d were observed for animals from LH, MH, and HH, respectively. No differences were observed for ADG throughout the finishing phase ($P = 0.18$) between MH and HH (1.12 and 0.91 kg/d, respectively) feeding managements. However, animals from LH had the greatest ADG (1.45 kg/d) compared to animals from the other feeding managements evaluated.
The MFI is positively correlated to meat tenderness as it measures the degree of proteolysis postmortem. Different than expected, no differences were observed ($P > 0.05$) for MFI values between experimental treatments at the end of the growing phase, when animals had

different growth rates and likely different muscular protein turnover. Such result likely explains the lack of differences (P > 0.05) in WBSF for beef from animals of different experimental treatments at the end of growing phase (Table 2).

Sarcomere length differed (P < 0.05) in muscle of cattle from different experimental treatments at the end of growing phase. Muscle from cattle from HH treatment had the greatest value of sarcomere length while the least value was observed in muscle form animals LH and intermediate values observed in muscle from animals MH, which did not differ from the other treatments (Table 2). Animals submitted to different feeding management present differences in composition of the body weight gain, in which animals with greater growth rate had greater carcass fat deposition and heavier weight. Consequently, the chilling rate may be altered and thus, carcass likely present different susceptibility for occurrence of cold shortening.

Effects of feeding management were observed for carcass fat thickness (P < 0.05) where carcass from animals in HH feeding management had the greatest value of fat thickness (2.35 mm) followed by carcass from animals within MH feeding management (1.72 mm), while animals fed LH had the least values compared to the other treatments (0.69 mm).

Although cold shortening negatively impacts the beef tenderness [7], this was not observed in the present study as no effects of feeding management were observed (P > 0.05) for WBSF of beef at the end of the growing phase.

According to Bruce *et al.* [7], the major impact of cold shortening on meat tenderness occurs when the sarcomere length is shorter than 1.5 µm, which was not observed in the current study where the average value of sarcomere length was 1.88 µm, at the end of growing phase.

The average value of WBSF observed at the end of the growing phase did not differ (P > 0.05) among treatments (Table 2). The average value of WBSF observed (4.06 kgf/cm²) characterizes beef as tender, as according to Destefanis et al. [7] meat that present shear-force values lower than 4.4 kgf/cm².

Table 2. Means of meat quality traits variables according to experimental treatments.

Items[1]	Treatments			SEM[2]	*P*-value
	HH	MH	LH		
Growing phase	(n=6)	(n=6)	(n=5)		
MFI	21.70	19.20	23.82	3.23	0.582
SL	2.01[a]	1.87[ab]	1.75[b]	0.06	0.024
WBSF	3.91	4.07	4.19	0.28	0.768
Finishing phase	(n=6)	(n=6)	(n=5)		
MFI	25.90	30.45	23.63	6.21	0.710
SL	2.08	2.07	2.04	0.08	0.920
WBSF	4.06	3.68	4.09	0.40	0.700

[1]MFI= Myofibrillar fragmentation index, SL= Sarcomere Length, WBSF= Warner-Bratzler shear force.
[2]SEM= standard error of the mean.
Means within a row with different letters are significantly different (P < 0.05).

There was no effect of feeding management (P > 0.05) for MFI at the end of the finishing phase although animals from LH had the greatest gain rate (compensatory growth) in this phase. However, the effect of compensatory growth on muscular protein turnover is time-dependent. If the re-alimentation period is longer than 11 weeks, the protein turnover between animals in continuous and compensatory growth becomes equivalent [3].

In the present study cattle were slaughtered 112 days (16 weeks) after the beginning of the re-alimentation, which may led to the equivalence of protein turnover among animals in continuous and compensatory growth being a possible explanation of the lack of differences in MFI values.

No effect of feeding management was observed (P > 0.05) for sarcomere length at the end of the finishing phase. The absence of differences in sarcomere length among treatments likely occurred due to heavier weight of the carcasses and greater values of carcass fat thickness (> 3.6 mm), which avoided the sudden drop of temperature during the chilling period. Our observations is in accordance to those reported by Purchas *et al.* [9], who did not observed differences on sarcomere length in muscle of animals in continuous or compensatory growth even though they had differences in carcass fat thickness.

No differences were observed (P > 0.05) for WBSF among treatments at the end of the finishing phase. Nonetheless, the values of shear force observed also characterize the evaluated samples as tender according to the values reported by Destefanis *et al.* [8].

IV. CONCLUSION

The use of different feeding managements to achieve continuous or compensatory growth of Nellore cattle does not affect the tenderness of beef.

ACKNOWLEDGMENTS
We thank INCT Ciência Animal, FAPEMIG, CAPES and CNPq for the financial support.

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