Meat Science 90 (2012) 770–774

Contents lists available at SciVerse ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Influence of genetic type and level of concentrate in the finishing diet on carcass and meat quality traits in beef heifers

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ARTICLE INFO

Article history:
Received 27 January 2011
Received in revised form 19 July 2011
Accepted 2 November 2011

Keywords:
Angus
Feedlot
Nellore
Simmental

ABSTRACT

Carcass and meat quality traits of thirty-six feedlot beef heifers from different genetic groups (GG) fed at two concentrate levels (CL) were evaluated using 12 - Nellore (NE), 12 - ½Angus x ½Nellore (AN) and 12 - ½Simmental x ½Nellore (SN) animals. Six heifers of each GG were randomly assigned into one of two treatments: concentrate at 0.8% or 1.2% of body weight (BW). Heifers fed concentrate at 0.8% of BW had greater ($P<0.05$) dressing percentage. None of the proximate analysis components of the beef were affected ($P>0.05$) by either CL or GG. Heifers from the AN group had higher ($P<0.05$) carcass weights, 12th rib fat thickness and lower dressing percentage ($P<0.05$) compared to the other groups. NE heifers had greater WBSF values ($P<0.05$) than the other genetic groups. Data suggest that the concentrate level can be reduced without compromising meat quality traits.

1. Introduction

In order to meet the market demand for beef, producers in Brazil have been adopting production strategies for finishing feedlot heifers due to their ability to reach harvest weight in a relatively short period of time (20–24 months of age). Although finishing heifers in the feedlot is not commonly observed in Brazilian beef production systems, the manipulation of diets and conditions represents an available tool to increase productivity (Paulino et al., 2008).

The use of feedlots and high concentrate diets for beef production has been increased in Brazil, among other reasons, due to a better efficiency of use of these diets than roughage based diets (Resende et al., 2001). Therefore, researchers have suggested that increasing concentrate levels in diets of feedlot heifers can improve carcass dressing percentage (Duarte et al., 2011; Silva et al., 2002) which is a really important characteristic for a beef cattle production chain since it establishes the weight upon which payment is calculated for animals sold on a live weight basis.

In addition to beef cattle production, meat quality has been identified as one of the major problems for the beef industry, whereas the uniformity, lack of fatness and inadequate tenderness are the main problems faced by meat producers in Brazil. Some studies have suggested that controlling the genetics of the slaughter cattle population would minimize the problem with tenderness since genetics makes a large contribution to the total variation in tenderness.

In this context, the use of crossbred animals represents an alternative that can be used to improve livestock production efficiency and beef quality. It is well documented that the mean shear force and variation in shear force increases as the percentage of *Bos indicus*, such as Nellore, inheritance increases (Crouse et al., 1989). Furthermore, meat from ½ or greater *Bos indicus* cattle is usually significantly less tender than meat from cattle with less than ½ *Bos indicus* (Bianchini et al., 2007; Vaz & Restle, 2005). However, there are a limited number of studies aiming to identify the effects of crossing between Nellore and different European breeds on carcass and beef quality.

Therefore, this study was carried out to evaluate carcass and meat quality traits of heifers from different genetic groups, fed two different levels of concentrate.

2. Material and methods

2.1. Animals and management

The trial was conducted at the Federal University of Viçosa in Brazil, following the humane animal care and handling procedures, according to the guidelines of the Federal University of Viçosa (Brazil).

Thirty-six intact heifers with average age of 18 months: 12 Nellore "*Bos indicus*" (NE); 12 ½Simmental x ½Nellore (SN); 12 ½Angus x

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doi:10.1016/j.meatsci.2011.11.012

½Nellore (AN) were treated for internal and external parasites by administration of ivermectin (IVOMEC®) prior the beginning of the experiment. The animals were confined to individual stalls with feeders and drinkers and a total area of 30 m^2.

The animals were submitted to a period of 15 days of adaptation prior the beginning of the experiment. At the beginning of the experiment, cattle were weighed after a 16-h solid fast in order to obtain the average initial shrunk BW (**SBW**), which were 247 ± 14.4 kg for NE, 255 ± 37.7 kg for SN and 292 ± 15.7 kg for AN. Regarding CL, the initial SBW were 264 ± 28.8 and 268 ± 33.2 for animals fed concentrate at 0.8% and 1.2% of BW, respectively. Six cattle of each group were randomly assigned to one of two treatments: either fed concentrate at 0.8 or at 1.2% of BW. Concentrate levels were adjusted to BW every 28 days when the animals were weighed. Diets were fed as total mixed ration and cattle were fed twice daily (at 0700 and 1500) allowing for up to 10% of orts. Corn silage (6.96% of crude protein; 5.07% of Ashes; 2.52 of ether extract; 50.82% of neutral detergent fiber; and 28.27% of dry matter) was used as only source of roughage. Concentrates were composed of corn meal, soybean meal, urea/ammonium sulfate, and were mixed with corn silage every day prior to animal feeding. The ingredients proportion and chemical composition of the diets are presented in Table 1.

2.2. Harvest, carcass traits and sample processing

At the end of the trial, heifers were harvested at the slaughter facility of *Universidade Federal de Viçosa*. Pre-harvest handling was in accordance with good animal welfare practices, and slaughtering procedures followed the Sanitary and Industrial Inspection Regulation for Animal Origin Products (Brasil, 1997).

After the slaughter, the hot carcass weight (HCW) and carcass fifteen minute pH were recorded. All carcasses were refrigerated at 4 °C for approximately 24 h. After the postmortem chill period, ultimate carcass pH (pHu), cold carcass weight (CCW), 12th rib fat thickness (RFT) and 12th rib longissimus muscle area (LMA) were measured on the left side of each carcass. Longissimus muscle areas were traced on transparencies and measured later with a planimeter and RFT measurements were taken ¾ the length ventrally over the longissimus muscle (Greiner et al., 2003).

The difference between the chilled carcass weight and HCW was used to calculate 24 h chill shrink. Dressing percent was calculated using HCW and CCW divided by final SBW and then multiplying the result by 100.

A boneless longissimus section 10 cm thick was removed from the posterior end of the wholesale rib. Longissimus muscle samples were individually vacuum-packaged and held at −20 °C for 2 days. Each frozen *Longissimus* sample was standardized from the posterior end into one 2.54 cm thick steak sample (AMSA, 1995) for Warner-Bratzler shear force measurement and two 1 cm thick steaks, one for determination of myofibril fragmentation index (MFI) and the other for proximate analysis. All steaks were vaccum package and held at −20 °C for 10 days until the analysis were performed.

Table 1
Ingredients and chemical composition of experimental diets.

	Concentrate levels (%)	
	30	50
Ingredient proportion (% DM)		
Corn silage	69.1	50
Corn ground	23.37	38.95
Soybean meal	5.49	9.16
Urea/ammonium sulfate	1.14	0.40
Salt	0.3	0.5
Commercial premix[1]	0.3	0.5
Magnesium oxide	0.10	0.17
Sodium bicarbonate	0.20	0.33
Chemical composition (% DM)		
Dry matter	38.11	45.35
Organic matter	94.99	94.96
Crude protein	12.46	12.42
NDFap[2]	34.85	27.89
CHO	79.62	79.32
NFCap	44.77	51.44
Ether extract	2.92	3.21

[1]Contained 24% Ca; 17.4% P; 100 mg/kg Co; 1250 mg/kg of Cu; 1795 mg/kg of Fe; 2000 mg/kg of Mn; 15 mg/kg of Se; 5270 mg/kg of Zn; and 90 mg/kg of I.
[2]NDFap = Neutral detergent fiber corrected for ash and protein; CHO = Total carbohydrates; NFCap = Non-fiber carbohydrates corrected for ash and protein.

2.3. Warner–Bratzler shear force measurement

Warner–Bratzler shear force (WBSF) steaks were thawed at 4 °C for 24 h and oven-broiled in an electric oven (Layr, Luxo Inox) preheated to 150 °C. 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 35 °C, the steak was turned over and allowed to reach an internal temperature of 70 °C before removal from the oven. Cooked WBSF steaks were cooled for 24 h at 4 °C (AMSA, 1995). Eight round cores (1.27 cm diameter) were removed from each steak parallel to the long axis of the muscle fibers (AMSA, 1995). 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).

2.4. Thaw and cook loss

Steak thawing and cook loss were evaluated on the steaks that were also used for WBSF measurement. For thawing loss evaluation, each steak was weighed frozen and after a period of 24 h at 4 °C. Cook loss of each steak was recorded after steaks were oven-broiled. Total cooking loss was calculated as the difference between the weight of the steaks before and after oven-broiling. The total cooking loss minus drip loss represented the evaporative loss. The total liquid loss was calculated by the difference between the weight of frozen and cooked steak.

2.5. Myofibril fragmentation index

Myofibril fragmentation indices (MFI) were determined on fresh muscle according to the procedures of Olson et al. (1976) and modified by Culler et al. (1978). Four grams of minced muscle were homogenized for 30 s in 10 vol (v/w) of a 2 °C isolating medium consisting of 100 mM KCl, 20 mM K phosphate, 1 mM EDTA, 1 mM MgCl, and 1 mM sodium azide. The homogenate was centrifuged at 1000 × *g* for 15 min and then the supernatant was decanted. The sediment was then resuspended in 10 vol (v/w) of isolating medium using a stir rod, centrifuged again at 1000 × *g* for 15 min and the supernatant was decanted. The sediment was resuspended in 2.5 vol (v/w) of isolating medium and passed through a polyethylene strainer (18 mesh) to remove connective tissue and debris. An additional 2.5 vol (v/w) was used to facilitate passage of myofibrils through the strainer. The protein concentration of the myofibril suspension was determined by the biuret method as described by Gornall et al. (1949). An aliquot of the myofibril suspension was diluted with an isolating medium to reach a protein concentration of 0.5 ± 0.05 mg/ml. Protein concentration was determined by the biuret method. 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 200 to give a MFI for each sample.