PE9.11 Effect of finishing systems on meat quality and fatty acid composition of Uruguayan steers 75.00

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Abstract— Nutritional influences on meat quality and fatty acid composition of intramuscular fat Uruguayan steers have been investigated focusing on their potential significance in beef palatability and human health. Sixty steers were finished during 120 days (d) using different combination in time of grain supplementation on pastures (SP) and silage plus concentrate (EC) (T1: EC for 120d; T2: SP for 40d followed by 80d EC; T3: 80d SP and 40d EC, and T4: 120d SP). A tendency was observed that steers on a 120d or 80d EC had heavier carcasses (difference (P<0.05) in hot carcass weight (HCW) between T1 and T3 carcasses was found) and more marbling (Marb) than cattle from the other treatments. Fat color was affected by treatments being more yellow carcasses from T4. The lipid content (IMF) was also higher in T1 beef. The meat concentration of linolenic (18:3 n-3) was higher (P < 0.05) from animals with 80 and 120d SP than those from 120 and 80d EC. The polyunsaturated: saturated fatty acids (PUFA:SFA) ratios for T1, T2, T3 and T4 were 0.11, 0.12, 0.14 and 0.12, respectively (P>0.05). The omega 6: omega 3 (n6:n3) ratios were 4.29, 3.93, 3.85 and 3.45, respectively. This ratio was different (P<0.05) between meat coming from steers on 120d EC than those from steers with a minimum of 80d SP. It concluded that finishing cattle on at least 80d EC had better meat quality traits (meat and fat color) but some concerns arise for nutritional value of meat since n6:n3 ratio was observed, mainly in 120d EC beef.

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Index Terms- beef, diet, meat quality, fatty acid composition.

I. INTRODUCTION BEEF

cattle production systems in Uruguay rely almost exclusively on grazed pastures. However, more recently intensive beef production systems have gained interest for promoting a better animal performance and meat quality attributes. However, some of these production systems differ from the typical feedlot grain-based diet applied in the United States, particularly in the different proportions of silage and grain used in both countries. Dietary recommendations for humans promoting the consumption of less saturated fat have led to an increased interest in meats containing more unsaturated fatty acids. The nutritional background may alter the fatty acid composition of ruminant tissue fat. Recent research has focused on the nutritional importance of the n6:n3 fatty acid ratio in the human diet as well as the effect of conjugated linoleic acid (CLA) isomers because of their anticarcinogenic properties [7], since ruminant fats are a natural sources of CLA, in particular the cis-9, trans-11 isomer, which arises from microbial hydrogenation of dietary linoleic acid in the rumen [11]. The objectives of this study were to study the effect of a combination of finishing time on pasture with grain supplementation (SP) and silage plus concentrate (EC) within a period of 120d on meat quality and fatty acid composition of Hereford steers.

II. MATERIALS AND METHODS

Sixty steers of 20-24 months of age, background on pasture, were finished on a combination of time and diet during 120 days on winter. The initial liveweight (LW) of the steers was 354 kg. They were randomly assigned to one of the following treatments: 1) 120d in EC; 2) 40d on SP and 80d in EC; 3) 80d on SP and 40d in EC and 4) 120 d on SP. Cattle grazed on a mixture of oat and rye grass pasture (DM: 2530 kg/ha; CP: 13%, ADF: 35.4%). The DM allowance was 5% of the LW and sorghum grain was used for supplementation (1% LW). The EC diet was formulated to provide 1.3

kg daily gain, and consisted of 40% corn and sorghum silage and 60% concentrate (sorghum grain, sunflower meal and nucleus). The steers were slaughtered in a commercial packing plant. Carcasses data was recorded (HCW) and were cut between the 10-11th ribs at 36 h postmortem, measuring fat thickness, pH, meat and fat color. Steaks for fatty acid analysis were individually vacuum packaged and frozen for subsequent analysis. Steaks were submerged in liquid nitrogen (-196oC), pulverized and stored at -20oC. Total lipid was determined by chloroform-methanol procedure of [5] modified by using a 10:1 ratio of chloroform-methanol for sample. Extract containing approximately 25 mg of lipid was converted to fatty acid methyl esters (FAME) using the method of [9]. The FAME were analyzed using a Konik HRGC 4000B gas chromatograph, and separated using a 100-m SP 2560 capillary column (0.25 mm i.d. and 0.20 μm film thickness, Supelco, Bellefonte, PA). Column oven temperature was programmed at 140 to 165oC at 3oC/min, 165 to 220oC at 5oC/min for 10 min and held at 220oC for 50 min with a split ratio: 0.42. The injector was maintained at 230 oC and detector at 240oC. Nitrogen was the gas carrier at a flow rate of 1 mL/min. Individual fatty acids were identified by comparison of retention times with standards (Sigma, St. Louis, MO; Supelco, Bellefonte, PA; Matreya, Pleasant Gap, PA). Results were analyzed by analysis of variance using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC, 2008). LSM means and differences among treatments were estimated, using $\alpha = 0.05$ level.

III. RESULTS AND DISCUSSION

The effect of feeding treatments on carcass traits is shown in Table 1.

Table 1 - Mean carcass traits of steers.

Traits	T1	T2	T3	T4
HCW, kg	272.3[a]	271.0[ab]	263.1[b]	265.7[ab]
Fat depth, mm	9.8	10.1	9.4	9.6
Marbling	360	343	317	330
IMF, %	5.13[a]	4.26[ab]	4.01[b]	4.37[ab]

[a,b]Means within the same row with uncommon uperscripts differ (P<0.05).

The carcasses from steers of T1 had heavier HCW, being different (P<0.05) from carcasses of T3 (272.3 kg vs 263.1 kg, respectively). No differences (P>0.05) were found in HCW among carcasses from T2, T3 and T4. The IMF content was higher (P<0.05) in steers finished in 120d EC (5.13%) than those assigned to T3 (4.01%). This tendency was also observed in marbling score where steers of T1 had higher levels (Sl60) of this trait although no difference (P>0.05) were detected among all treatments. Objective color measurements of longissimus muscle (LD) and intermuscular fat at the 10/11th rib interface were taken at 36 h postmortem. LD of animals finished on EC for 120 and 80d had better L* values than those with more time on SP, indicating a darker colored lean. For intermuscular fat, carcasses from 120d SP fed cattle had lower (P<0.05) L* values than carcasses that had a period of EC (40 d or more) and also had higher b* values than steers from T1 indicating more yellowness. Numerous studies have consistently shown that feedlot-finished cattle have whiter fat color scores than grass-fed animals [10]. The composition of the ration fed to EC cattle in the present study is different from the corn- or sorghum-based feedlot rations used in the feed lots of USA or Australia. The fatty acid composition of longissimus IMF for all treatments is presented in Table 2. These values are higher than the mean fat contents reported by [10]. The main fatty acids in the IMF for all treatments were oleic (18:1), palmitic (16:0) and stearic (18:0), which accounted for 81.5 % to 85.8 % of the total fatty acids analyzed. The percentages of palmitoleic (16:1) and oleic (18:1) acids were higher (P<0.05) in IMF of T1 and T2 beef than those with more days on pastures. However, as it was expected these steers from T3 and T4 had steaks with higher (P < 0.05) concentrations of linolenic (18:3 n-3) than those from T1 and T2 animals. In this study, it was not clear the difference in long chain PUFA (arachidonic,20:4; eicosapentaenoic-EPA,20:5 and docosapentaenoic-DPA, 22:5) acids among treatments. [10] have shown greater concentrations of stearic, linolenic, EPA, DPA and arachidonic acids in grass-fed than concentrate-fed animals. Total CLA did not vary (P>0.05) among treatments. Previous research has shown that including grass in the diet of beef cattle increased CLA concentration in IMF. The meat from animals of all treatments contained a similar (P > 0.05) proportion of SFA, although T1 and T2 beef had a higher (P < 0.05) concentration of monounsaturated fatty acids (MUFA) than T3 and T4 beef. The percentage of PUFA was higher (P<0.05) in T3 meat than T1 and T2 feeding diets. The UK Department of Health (1994) recommends that PUFA:SFA ratio should be around 0.45. In this study (Figure 1), the ratio was lower than this value (0.11 in T1 and 0.14 in T3). [3] also reported a higher ratio (0.26) for muscle

from grass-finished steers than for that from concentrate-finished animals (0.07). Similar ratio to feedlot cattle have been reported for [4] and [8]. An increase in the consumption of n-3 fatty acids is also recommended [2] being n6:n3 ratio below 4. The n6:n3 ratio (Figure 1) was higher ($P<0.05$) in T1 beef (4.29) than T3 and T4 beef (3.85 and 3.45, respectively).

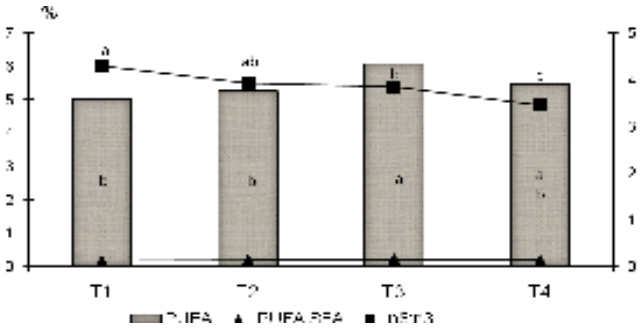

Figure 1 – PUFA content, PUFASFA and n6:n3 ratios for all treatments

[1] using Hereford steers showed n6:n3 ratios of 2.5 and 2.4 for grain supplementation at 0.6 and 1.2% LW, on pastures during 111 and 83 days of finishing, respectively. [6] reported ratios of 2.33 and 4.15 for grass-fed and concentrate-fed steers. Differences are mainly due to fatty acid composition of the diet, where α-linolenic acid (18:3 n-3) is the major fatty acid in grass lipids, while linoleic acid (18:2 n-6) is in grains.

IV. CONCLUSION

Steers 120d in EC has heavier HCW and LD steaks with higher values of IMF and MARB score. As it is shown in the literature 80 and 120 days in feedlot determine a better meat quality, mainly in color. These animals showed a better values in L* muscle and L* and b* intermuscular fat. Beef from SP or even from only 40 d in EC resulted in a higher content of 18:3 n-3 (α- linolenic acid) than beef from a minimum of 80 days in EC. No differences were found in linoleic acid and CLA among treatments, although it was expected that beef from longer periods on EC had higher content of 18:2 n-6 and lower levels of CLA, comparing with feeding systems based mainly on pastures. The n6:n3 ratio in IMF was higher from steers in 120d EC, not achieving the recommended levels for the UK Department of Health. Results from this study suggest that the combination of different feeding strategies will be according to market demands, considering meat quality attributes (color and IMF content) or human health perspective.

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Table 2 - Intramuscular fatty acid composition

Fatty acid, %	T1	T2	T3	T4
14:0, *myristic*	2.88[ab]	3.12 [a]	2.51[c]	2.57[bc]
14:1, *myristoleic*	0.34	0.35	0.34	0.36
16:0, *palmitic*	28.06	29.07	28.20	28.43
16:1, *palmitoleic*	4.18[a]	4.41[a]	3.70[b]	3.89 [b]
18:0, *stearic*	13.88	13.33	13.78	14.14
18:1, *n-9 oleic*	43.93[a]	41.94[b]	39.55 [c]	40.45[bc]
18:2, *n-6 linoleic*	2.84[b]	2.93[b]	3.50[a]	2.98[b]
18:3, *n-3 linolenic*	0.29[b]	0.30[b]	0.53[a]	0.56[a]
18:3, *n-6 linoleic*	0.20[a]	0.16[b]	0.16[b]	0.15[b]
CLA	0.39	0.39	0.38	0.39
20:3, *n-3*	0.21	0.22	0.25	0.21
20:4, *n-6 arachidonic*	0.66[b]	0.75[ab]	0.88[a]	0.77[ab]
20:5, *n-3 EPA*[*]	0.15[ab]	0.20[a]	0.09[b]	0.08[c]
22:5, *n-3 DPA*[*]	0.24[b]	0.27[ab]	0.31[a]	0.29[ab]
SFA[*]	44.83	45.52	44.49	45.15
MUFA[*]	48.46[a]	46.71[a]	43.59[b]	44.70[b]
PUFA[*]	5.02[b]	5.26[b]	6.08[a]	5.47[ab]

[a,b,c]Means within the same column with uncommon superscripts differ $P < 0.05$
[*]CLA: conjugated linoleic acid, EPA: eicosapentaenoic acid, DPA: docosapentaenoic acid, SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids.