FINISHING ON SMALL-GRAIN WINTER ANNUALS OR ALFALFA PASTURE: I. ANIMAL PERFORMANCE, CARCASS, PHYSICAL AND SENSORY QUALITY OF BEEF

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Abstract – Effects of finishing on pure stands of small-grain winter annual pastures or alfalfa on animal growth, carcass and meat characteristics were investigated using 120 Angus steers to determine the potential benefits of forage species on beef quality. Treatments were: 1) cereal rye (Rye), 2) triticale (Trit), 3) wheat (Wheat), and 4) alfalfa (Alf). Each treatment consisted of 3 pasture replicates with 10 animals each. Treatments did not differ in initial and final weights ($P > 0.431$), but, Alf took 22 longer to reach the final slaughter endpoint (98 days for Rye, Trit and Wheat vs 120 for Alf). Carcass characteristics and shear force of *longissimus dorsi* muscle (LM) were similar ($P > 0.10$) among treatments. Color L* factor of LM was higher for Alf ($P < 0.001$). The sensory panel detected Alf juicer ($P = 0.025$) and more tender than the others ($P < 0.04$). Rye had greater ($P < 0.01$) off-flavor. Results suggest that finishing beef on small-grain pastures or alfalfa produces highly tender and desirable beef. And, despite the lower weight gain on alfalfa pasture, beef finished on alfalfa could be more desirable than beef from winter annuals.

Key Words: Feeding strategy; Pasture finishing; Beef tenderness.

I. INTRODUCTION

Interest in pasture finished beef has increased in the recent years as a way to increase intake of leaner meats and healthy fats. Research has repeatedly shown the relevance of forages to improve n-3 PUFA in beef [1, 2, 3]. Few studies, however, have researched the effects of the forage base on physical and chemical characteristics of beef [4, 5]. Dierking *et al*. [4] detected effects of forage sources on growth and physical characteristics. Use of small-grain winter annuals during winter and early spring is a common practice in pasture finishing programs of central Argentina. In turn, alfalfa pasture is the common forage on which pasture finishing takes place during spring and summer. Recently, effects of alfalfa pasture on beef characteristics have been reported in the literature [3, 4, 5, 6, 7], where alfalfa beef has been described as tender as feedlot beef. No reports, however, have been published on the effects of small-grain winter annuals on beef quality. This study examined the effects of finishing on pure stands of winter annuals, compared with alfalfa, on physical, sensory characteristics of Argentinean beef.

II. MATERIALS AND METHODS

The study was carried out at the Agricultural Experiment Station of INTA Anguil, La Pampa, Argentina. One hundred and twenty Angus steers used in 4 treatments: 1) finishing on pure stands of cereal rye (Rye), 2) triticale (Trit), 3) wheat (Wheat) pasture, and 4) alfalfa pasture (Alf). Small-grain winter annuals were planted in 3 pasture replicates randomly distributed on a 75-ha field. Each treatment included 10 animals in each replicate, randomly allocated from a group of spring born steers of similar age and live weight (LW) (551 ± 16.1 d old; 373 ± 17.5 kg). For Alf, 3 alfalfa pasture replicates were randomly chosen from a 35-ha field of 100% alfalfa, previously subdivided in 6 pastures. Thirty fall-born steers of similar age and weight (540 ± 14.5 day old; 374 ± 7.8 kg) and of similar weight to the previous group were randomly selected and allocated to the 3 alfalfa pasture replicates. Small-grain pastures were grazed during 98 d of winter, from June 10th through September 16th. The alfalfa pastures were grazed for 120 days during spring and summer, from October 25th through January 22nd. Paddock size was managed to offer forage above 8% of the animal's live weight (LW) (on dry matter -DM-basis) daily to avoid restrictions on intake. Availability was estimated by clipping 5 ½ m^2 circle samples and paddock size adjusted accordingly before entering each new paddock. Rotational grazing was implemented using a 2-day grazing: 45-day rest rotation scheme for small grains and a 2-day grazing: 35- day rest scheme for alfalfa. Paddocks were mowed after each grazing to allow for clean re-growth. Animals were weighed individually using an electronic scale on day 0, 32, 64 and 98 and of the study for treatments on small grains (Rye, Trit and Wheat), and on day 0, 32, 64, 98 and 120 for animals on Alf, after a 17-hour fast (with access to water). Animals from winter annuals and Alf were slaughtered at the end of a 98-day and 120-day period, respectively, when all animals from each group were above 450 kg of LW and considered finished by commercial buyers. After slaughter, carcasses were individually graded, weighed to determine hot carcass weight (HCW), and chilled at 2°C. Forty eight hours after slaughter, a rib section encompassing the 10th to 13th ribs was removed from the left side of each carcass. The rib sections were individually identified, vacuum packaged and kept for an additional 24-hour period at 2 °C. After chilling for 96 hours, rib sections were frozen and stored at -20 °C. For analysis, rib sections were split between the 12th and 13th rib using an electric saw. The 12th/13th rib interface was used for measuring back fat thickness (BFT), and *longissimus dorsi* muscle (LM) area (REA). After thawing for 24 hours at 4 °C and at room temperature for 4 hours, a10-g aliquot of each LM portion of the 12th-rib section was used for determination of intramuscular fat (IMF). Fat was extracted with solvent (hexane) in a Tecator apparatus (Method 991.36 [8]). In preparation, samples were trimmed of external fat, and minced using a blade grinder.

Steaks from the 13th rib were used in determination of Warner-Bratzler shear force (WB). Cooking loss was determined by dividing the weight loss during cooking by the pre-cooked weight and reported as a percentage. Intramuscular pH was measured in the LM section of steaks from the 12th rib. Color determinations were performed on the rib eye section and the outside fat layer of steaks from the 13th rib prior to processing for shear force. A B-K Gardner Color Vie Spectrophotometer (model 9000, USA) was used, according to AMSA [9]. The CIE Lab System was implemented, which provided the values for color components: L* (black-white, lightness) and the chromatic coordinates a* (+ to – from red to green) and b* (+ to -, from yellow to blue component). The 11th rib sections were used to prepare steaks (2.5-cm thick) for sensory evaluation. After thawing and deboning, the resulting steaks were weighed and placed in a pre-heated electric grill until they reached a final internal temperature of 71 ± 0.5 °C. After cooking, each steak was trimmed of fat and connective tissue, and the LM section was cut into 1-cm^3 cubes and immediately served to an eight-member sensory panel [9, 10]. The samples were evaluated using a nine-point non-structured linear scale for juiciness (1 = extremely dry, 9 = extremely juicy), initial and sustained tenderness (1= extremely tough, 9 = extremely tender), and amount of connective tissue (1 = very much, 9 = none). Panel members were also asked to report the intensity of beef flavor (1 = extremely bland, 9 = extremely intense) and off-flavor on a 9-point scale (0 = none, 1= extremely slight off-flavor to 8 = intense off-flavor).

Statistical analyses. Data were analyzed with a model including a complete randomized design with forage source in the main plot, using GLM procedures of SAS [11]. Pasture replicate was the experimental unit. Least square means were generated and separated using PDIFF option of SAS. Orthogonal contrasts were applied to separate effects of Rye vs Trit, Rye and Trit vs Wheat, and winter annuals (Rye, Trit and Wheat) vs Alf.

III. RESULTS AND DISCUSSION

No interactions were detected ($P > 0.10$) between treatments and LW across periods. Treatments were similar ($P = 0.431$) in final LW at slaughter. Treatment Alf took 22 days longer to reach the slaughter endpoint. Consequently, ADG was lower ($P < 0.01$) for Alf, compared to Rye, Trit and Wheat (Table 1). No differences ($P = 0.677$) were detected in ADG for the cereal-grain pastures, which averaged 1024 ± 62.1 g/day. No treatment effects were detected (P > 0.306) for HCY, REA, BFT, pH, WB shear force and cooking loss. Treatment effects were detected on IMF content (P < 0.001). Alf had a similar content (P = 0.183) to Wheat. But the average of grains differed from Alf (P < 0.012). Rye resulted in the lowest (P < 0.01) content.

Table 1. Effect of finishing on cereal rye (Rye), triticale (Trit), wheat (Wheat) or alfalfa (Alf) pasture on weight gain, carcass traits and physical characteristics of Angus steers

	Rye		Trit		Wheat		Alf		SEM	Model	*P*-values for contrasts		
										P-value	Rye vs	Rye & Trit	Annuals
										F > Fo	Trit	vs Wheat	vs Alf
Period, d	98		98		98		120		-	-	-	-	-
Initial LW, kg	374		373		373		374		11.6	0.918	-	-	-
Final LW, kg	473		472		477		475		11.9	0.431	-	-	-
ADG, g d^{-1}	1001	b	1010	b	1061	b	842	a	32.4	0.002	-	-	-
HCY, %	57.3		58.2		58.4		57.6		0.87	0.325	-	-	-
REA, cm^2	68.4		68.1		68.6		69.2		1.58	0.746	-	-	-
BFT mm	7.5		8.5		8.1		7.9		0.55	0.623	-	-	-
WB, N	34.2		33.1		31.6		34.8		1.72	0.775	-	-	-
pH	5.7		5.6		5.6		5.6		0.043	0.856	-	-	-
IMF, g 100^{-1} g	2.73	a	3.37	b	3.61	c	3.44	b, c	0.054	0.001	0.001	0.001	0.012
Cooking loss, %	29.1		28.7		28.8		27.6		0.369	0.306	-	-	-
Juiciness	5.81	a	6.35	a,b	6.84	b	8.13	c	0.163	0.025	0.173	0.031	0.002
Initial tenderness	6.56	a	6.67	a	6.81	a	7.65	b	0.102	0.002	0.232	0.189	0.003
Sust. tenderness	6.78	a	6.99	a	6.36	a	7.44	b	0.117	0.004	0.277	0.089	0.041
Conn tissue	6.57		6.32		6.45		6.6		0.085	0.605	-	-	-
Beef flavor	6.15		5.93		6.06		6.78		0.027	0.071	-	-	-
Off-flavor	6.27	b	4.92	a	4.73	a	4.55	a	0.107	0.011	0.003	0.245	0.495
Muscle color													
L	34.5	a	34.8	a	37.7	b	39.5	c	0.28	0.001	0.781	0.001	0.001
a*	16.8		16.3		17.5		17.7		0.54	0.519	-	-	-
b*	13.3		12.6		11.2		12.5		0.51	0.337	-	-	-
Subcutaneous fat color													
L	64.2		66.7		65.5		66.3		0.73	0.233	-	-	-
a*	7.5		7.2		6.3		6.8		0.35	0.697	-	-	-
b*	22.6		19.5		21.5		23.3		0.82	0.554	-	-	-

n = 3 (pasture replicates); 3 pasture units $treatment^{-1}$ (10 animals in each pasture rep, 30 animals treatment).
ADG = Average daily gain; HCY = Hot carcass weight; REA = Rib eye area; BFT = Backfat thickness; WB = Warner-Bratzler shear force; IMF = Intramuscualr fat
[a,b,c] Row means followed by the same letter do not differ (*P* > 0.05).

Dierking *et al*. [4] reported effects of forage species on rate of gain and carcass parameters. No treatment effects were detected (P > 0.337) for a* and b* parameters of color of LM. But, treatment effects (P = 0.001) were detected for L*. Treatment Alf had greater (*P* = 0.001) value for L* compared with the other ones, and Wheat had greater (*P* < 0.001) L* than Rye and Trit.

No effects of treatments (*P* > 0.233) were detected on color parameters L*, a* or b* for subcutaneous fat.

Sensory panel detected (P < 0.025) treatment effects for juiciness and tenderness. Treatment Alf had greater (*P* < 0.002) juiciness than the other treatments. Among small-grain treatments, Wheat resulted in greater (*P* = 0.031) juiciness than the average of Rye and Trit (Table 1). On average, LM from Alf animals was found with greater initial (*P* = 0.003) and sustained (*P* = 0.041) tenderness, compared with the other treatments. No treatment effects (*P* = 0.605) were detected on connective tissue estimates that could be associated to tenderness. No effects of treatments were detected (*P* > 0.05) on beef flavor either. But, a treatment effect was detected (*P* = 0.011) on off- flavor. Rye resulted in greater (*P* = 0.003) off-flavor than triticale.

IV. CONCLUSION

Carcass parameters and quality profiles of beef determined in this study suggest that finishing cattle on small-grain winter annuals or alfalfa pastures has potential for producing high quality beef. Species of winter annuals may affect beef quality. Triticale and wheat pastures would generate more desirable, more marbled beef than cereal rye, and comparable with alfalfa pasture. Although not detected in shear force, alfalfa finished beef would be the preferred meat by sensory panel.

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