Implant-Free and Forage-Finishing: an Alternative Beef Production System for Carcass and Meat Quality Improvement

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The elimination of growth promotants (ionophores and anabolic implants) from beef production systems combined with the feeding of high proportions of forages is the basis of organic or natural livestock production (6) and is the response of beef producers to the requests from a growing segment of consumers for healthier animal products (2). The abandonment of hormonal implants may reduce the incidence of dark cutters and beef toughness whereas finishing on grass silage can help to achieve satisfactory quality grades and produce beef with improved shelf-life and higher tenderness score compared to grain-fed beef.

Material and methods

A total of 40 Angus cross steer calves were raised at the Kapuskasing Beef Research Farm in Northern Ontario and randomly assigned to five management regimens that differed during the growing (d 0 to d 98) and finishing (d 99 to slaughter) phases to account for changing animal requirements. Animals assigned to treatments GS/GP and GS/GP + HCON were implanted with Revalor G (40 mg of trenbolone acetate + 8 mg of estradiol) and were reimplanted 70 d later with Revalor S (120 mg of trenbolone acetate + 24mg of estradiol). During the growing phase (d 0 to d 98), steers on all management regimens had ad libitum access to grass silage. Solvent-extracted soybean meal was fed at 4% of the diet to GS + LCON steers or at 8% of the diet to GS + HCON, and GS/GP + HCON steers. After weighing steers on d 98, the diets of steers on treatment GS + LCON, GS + HCON, and GS/GP + HCON were gradually changed to energy dense diets. Animals on treatment GS + LCON were offered a total mixed ration composed of grass silage and rolled barley (60:40, DM basis), whereas steers on treatments GS + HCON and GS/GP + HCON were offered a total mixed ration composed of grass silage and rolled barley (30:70, DM basis). Cattle were adjusted gradually to grain-based diets by offering 75% silage and 25% barley for 7 d followed by 60% silage and 40% barley for 4 d. Thereafter, the proportion of barley was increased by 10% every 4 d until it reached 70% of the diet DM.

Cattle were slaughtered based on a backfat endpoint after attaining at least 8 mm of backfat (measured by ultrasound) at the 3/4 position over the *longissimus* muscle between the 12th and 13th ribs. After slaughter, carcass weights were recorded before overnight chilling at 1 ºC and the carcass dressing yield was calculated based on departure weight at the farm. Six d after slaughter, carcasses were graded at the interface between the 12th and 13th ribs in the normal manner by a single grader according to the Livestock and Poultry Carcass Grading Regulations (3) for determining carcass grade.

On the 6th day after slaughter, the striploin (13th rib-5th lumbar vertebra) was removed from one side of each carcass and taken to the cutting room of the Agriculture and Agri-Food Canada (AAFC) Research Centre in Sherbrooke (QC). Muscle pH was measured in the *longissimus dorsi* (LD) muscle at the interface between the 12th and 13th ribs. Two steaks (25 mm thick) were cut: one was used for colour (Minolta L*, a*, b*) assessment and the other was stored for 48 h at 2ºC for gravimetric drip loss measurement. A third chop was frozen for later analysis of cooking losses and Warner-Bratzler shear force (WBSF). The remainder of the fresh LD muscle was ground, vacuum-packed and frozen (–20ºC) pending analysis of intramuscular fat (IMF), protein and total haematin content, collagen solubility and myofibrillar fragmentation index (MFI).

Results

Carcass quality

With the exception of body and carcass weights that were increased ($P < 0.01$) by the use of growth promotants, carcass characteristics were unaffected by the use of a combined implant (trenbolone acetate + oestrogen) and ionophore in cattle either finished exclusively on grass silage or grain/forage diets (Table 1). The effects of hormonal implants on body and carcass weights are consistent with most of the literature (8) and reflect the higher ADG recorded in the growing and finishing phases of this study (1). Anabolic growth promotants are known to compromise carcass quality grades due to reduced marbling and increased proportion of dark cutters (8). However, neither marbling nor lean color nor, consequently, quality grades were affected by implants in this study.

Grain (barley) fed steers in the present study had heavier ($P < 0.01$) body and carcass weights than steers fed grass-silage. The feeding of a 70% barley diet increased dressing yield ($P = 0.04$) and average backfat thickness at the grading site ($P < 0.01$). These results are likely due to the higher dry matter intake and metabolic energy concentration of the supplemental barley in the diet. Although there was no effect of barley supplementation on rib-eye area or lean yield, this dietary treatment increased marbling score ($P = 0.03$) as a result of the higher fat deposition. The higher marbling score resulted in higher quality grade ($P < 0.03$) at each increase of barley concentration in the diet. Overall, increasing the proportion of barley from 0 to 70 % increased the percentage of carcasses graded AAA and AA by 24% (69.2% vs 93.3%). Finally, the significant increase ($P = 0.03$) in carcass quality grade found when growth promotants were replaced with moderate quantities of dietary supplements reinforces the above-mentioned effects of increased energy intake on fat deposition in the LD muscle.

Meat quality

Increased incidence of dark cutters and higher WBSF values have been associated with use of hormonal implants in past studies (8) where ionophores were usually incorporated into the diet. In the present study two dark cutters (based on pH > 6) were observed with both occurring in steers administered growth promotants. However, a growth promotant by concentrates interaction (GP x CON) was present ($P = 0.04$) for the a* value as muscle redness increased in grass-silage fed cattle administered growth promotants in contrast to a decrease in muscle redness when growth promotants were used with the high (70 %) concentrate diet (Table 2). This interaction is supported by a similar interaction ($P = 0.04$) in the haematin content of LD muscle with increases in haematin with use of growth promotants with grass silage feeding as compared to decreased haematin when growth promotants were used with the high concentrate diet.

Growth promotants increased ($P < 0.01$) WBSF regardless if cattle were finished on grass silage or a high concentrate diet. Since IMF and collagen content did not differ with the use of growth promotants, the increased tenderness of beef from steers fed without growth promotants may be mostly attributable to increased post mortem proteolytic changes during ageing as demonstrated by the higher MFI ($P = 0.02$) versus beef produced using growth promotants. Meat composition was not influenced by growth promotants when examining dry matter, IMF, protein, and total and soluble collagen.

Beef from animals grazing grass is usually darker and tougher than beef from animals fed concentrates (7). The reduced color lightness in the meat of grass-fed steers is usually linked to greater ultimate pH (pHu), lower marbling or increased myoglobin content in the muscle;

these traits are frequently associated with the age at slaughter for steers finished on grass (4). The increase in the pHu value is either due to lower glycogen reserves in the muscle or reduced fat coverage leading to faster cooling rates and slower post-mortem pH fall. In the present study, where beef were slaughtered at the same backfat level, diet (grass silage or concentrate) had no influence on pHu, color lightness (L*) or drip loss. As observed before, either feeding a high (70 %) concentrate or a grass-silage diet influenced the beef redness score (a* value) only when combined with growth promotants (GP x CON; $P = 0.04$).

Improved beef tenderness from cattle finished on grain diets is often reported in the literature (5). This effect may be either explained by an increased fat deposition in cattle fed high concentrate diets which prevents cold shortening of the carcass, or by the younger age of the animal at slaughter given the age effect on collagen maturity. However, the present study found no differences in WBSF values due to diet.

The feeding of the high concentrate diet increased ($P < 0.05$) DM and IMF content while reducing ($P < 0.02$) total collagen concentration versus cattle finished on grass silage. The reduced total collagen concentration can be explained by the higher growth rate of concentrate-fed steers and subsequently younger age at slaughter. However, soluble collagen content was similar across diets indicating the lack of effect of the higher dietary energy intake on this variable.

Conclusions

In the present study the use of growth promotants produced heavier carcasses, with tougher meat and more dark cutters. Forage finished natural beef has the potential to provide leaner and cherry red beef. Overall, these findings will be of interest to beef producers who invest in the niche production of forage-finished natural beef to meet the increasing demand from health conscious consumers. However, producers considering this feeding practice must be aware of the potential reduction in retail product yield which could in turn have an impact on financial returns and ultimate profitability.

References

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Table 1. Carcass quality traits of steers treated with growth promotants (GP) and fed dietary supplements

	Management Regimen						*P*- value[a]			
	GS	GS/GP	GS + LCON	GS + HCON	GS/GP + HCON	SEM	GP	CON	GP x CON	GS+LCON vs GS/GP
Body weight, kg	451.2	490.2	474.7	466.9	513.4	8.1	< 0.01	< 0.01	NS	NS
Carcass weight, kg	265.4	286.1	279.2	279.3	306.9	5.4	< 0.01	< 0.01	NS	NS
Dressing yield, %	58.8	58.4	58.7	59.9	59.8	0.6	0.75	0.04	NS	NS
Backfat at ¾ position, mm	7.5	7.3	8.8	10.8	8.9	1.0	0.50	< 0.01	NS	NS
Rib-eye area, cm^2	70.9	71.4	68.3	70.2	77.4	3.3	0.23	NS	NS	NS
Lean yield, %	59.8	59.4	58.0	57.0	59.1	1.2	0.47	NS	NS	NS
Marbling score[b]	4.9	4.7	5.4	5.6	5.4	0.3	0.52	0.03	NS	NS
Quality grade[c]	1.6	1.2	2.1	2.4	2.1	0.3	0.27	< 0.01	NS	0.03

[a] NS indicates non significant difference (*P* > 0.05)
[b] According to pictorial standards (from 1 = devoid to 10 = abundant marbling)
[c] AAA = 4, AA = 3, A = 2, B = 1.

Table 2. Effect of management regimen on meat quality traits

	Management Regimen						*P*- value[a]			
	GS	GS/GP	GS + LCON	GS + HCON	GS/GP + HCON	SEM	GP	CON	GP x CON	GS+LCON vs GS/GP
pH at 6 d	5.65	5.67	5.64	5.61	5.68	0.06	NS	NS	NS	NS
L*	37.66	36.73	37.73	37.79	37.67	1.02	NS	NS	NS	NS
a*	22.66	23.53	24.46	24.93	22.08	0.95	NS	NS	0.04	NS
b*	12.81	13.17	12.62	12.97	11.55	0.66	NS	NS	NS	NS
Drip loss (%)	2.02	2.43	2.33	2.20	2.26	0.28	NS	NS	NS	NS
Cooking loss (%)	29.2	30.7	27.3	28.9	30.2	0.99	NS	NS	NS	0.02
WBSF (kg)	4.5	7.0	4.4	4.9	6.2	0.7	< 0.01	NS	NS	< 0.01
MFI	122.73	93.53	117.52	114.75	100.03	9.83	0.02	NS	NS	0.07
Dry matter (%)	25.7	25.6	26.6	27.4	26.1	0.5	NS	0.03	NS	NS
IMF (%)	2.9	2.9	3.9	4.6	3.4	0.5	NS	0.05	NS	NS
Protein (%)	22.1	22.1	22.0	22.0	22.0	0.17	NS	NS	NS	NS
Total collagen	578.3	609.3	581.5	539.2	538.0	22.7	NS	0.02	NS	NS
Soluble collagen (mg/100g)	59.0	57.9	56.9	57.9	51.6	4.1	NS	NS	NS	NS
Total haematin (ppm)	167.9	177.0	178.1	177.5	152.6	8.1	NS	NS	0.04	NS

[a] NS indicates non significant difference (*P* > 0.05)