Effect of Liveweight Gain During Winter on Organ Mass and Organ Mass Accretion During Subsequent Feedlot Finishing

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Story in Brief

An experiment was conducted to determine the effect of liveweight gain during winter grazing on initial organ mass and organ mass accretion by beef steers during feedlot finishing. Forty-eight beef steers grazed either winter wheat to achieve maximal daily gain or approximately 1 lb/d of gain or dry winter native range before being placed into a feedlot for finishing. Our winter grazing treatments produced three populations of cattle with very different amounts of body condition entering the feedlot. This was evident from initial carcass characteristics. Initial tissue masses were different between treatment groups. High gaining wheat cattle had the greatest amounts of total splanchnic tissue; native range cattle had the least. As each group of cattle was finished final tissue masses were measured. Final total gastro-intestinal and total splanchnic tissue masses were similar among all treatments. Accretion rates during the feedlot phase for total gastro-intestinal tract was the greatest in cattle that grazed native range, and the least in high gaining wheat cattle. There were no differences between treatments in the accretion rate of total splanchnic tissues during the feedlot phase.

Key Words: Grazing, Feedlot, Growth, Splanchnic Tissue

Introduction

As cattle production moves towards more coordinated systems, grazing phases in these systems become more important. Sainz et al. (1997) reported that forage increased gastro-intestinal tract (GIT) organ mass and cellularity compared to grain diets. Additionally, the increase in organ mass can increase maintenance energy requirements, whereas reduced GIT organ mass could reduce cattle maintenance energy requirements. The visceral organs and GIT only account for 5 to 10% of the empty body weight (EBW) of cattle, whereas the GIT accounts for nearly 40 to 50% of the total heat production of the animal (Burrin et al., 1992). Moreover, plane of nutrition may affect the size of the metabolically active organs and may be responsible for changes in maintenance energy requirements (Burrin et al., 1992). Variation in the weight of the splanchinic tissues (GIT, liver and spleen) contributes to the adaptations in maintenance requirements of animals according to feeding level (Noziere et al., 1999). Therefore nutritional strategies that reduce GIT mass, but do not sacrifice animal performance, may be responsible for animals exhibiting compensatory growth when placed in a feedlot. As part of a larger experiment, we wanted to determine the effects of previous liveweight gain while grazing on tissue mass and accretion rates.

Materials and Methods

Characteristics of the cattle, grazing phase, and feedlot phase have been discussed in the preceding report (Hersom et al., 2001). Three different groups of cattle were produced during winter grazing; high gain wheat (HGW) steers grazed wheat and gained 2.82 lb/d, low gain wheat (LGW) steers grazed wheat and gained 1.6 lb/d, and native range (NR) steers grazed dry winter native range and were supplemented with 2 lb/d of a 41% crude protein supplement. After the grazing phase, four steers per winter treatment were harvested for body composition and determination prior to steers being placed into a feedlot. At the initial harvest, steers were stunned with a captive bolt gun, exsanguinated, and blood collected. We recorded weights of hot carcass, blood, head, hide, internal organs, and GIT organs. We weighed all organs immediately after removal from the carcass. We trimmed mesenteric fat and removed the contents from GIT organs before they were weighed. At the final harvest for each treatment, we selected two steers from each feedlot pen, or six steers per treatment, for composition measurements. Body composition measurements exactly replicated those of the initial harvest group. We calculated empty body weight (EBW) as BW minus the sum of GIT organ digesta contents.

Data were analyzed using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC) with least squares means calculated. Source of variation included in the model was previous winter grazing treatment. We considered animal the experimental unit for this analysis.

Results and Discussion

Initial Empty Organ Mass. Initial EBW of HGW steers was 24% greater ($P<.05$) than that of LGW and 39% greater than those of NR steers (Table 1). Similar to initial EBW, initial total offal of HGW steers was 23% greater ($P<.05$) than LGW and 40% greater than NR steers. The difference in initial total offal resulted from liver weights being approximately 3 g/kg EBW greater ($P<.05$) in HGW than in LGW or NR steers, and a greater ($P<.05$) amount of mesenteric fat in HGW steers than in LGW or NR steers (42 and 75%, respectively). The weights of the stomach complex (g/kg EBW) were greater ($P<.05$) in NR than HGW or LGW steers. Total GIT (g/kg EBW) was greater ($P<.05$) in NR steers than HGW steers and was similar to LGW steers. Total splanchnic tissue was greater in HGW steers than in NR steers, whereas total splanchnic tissue mass in LGW steers was intermediate.

Table 1. Initial organ and tissue weights of steers (g/kg of empty body weight)

Tissue	HGW	LGW	NR	SEM
Empty body weight, kg	370.67[a]	279.90[b]	226.16[c]	7.27
Total offal	1102.92[a]	1128.90[ab]	1176.16[b]	8.55
Hide	69.89[a]	76.69[b]	69.90[c]	1.90
Blood	37.82	37.48	39.00	1.91
Head	34.28	40.69	35.14	6.40
Feet and ears	25.88[a]	32.3[b]	33.51[b]	.59
Trim	17.00[a]	12.12[b]	10.67[c]	1.27
Heart	4.85	4.65	4.88	.12
Lung	11.67	14.22	14.47	1.03
Kidney	3.07	2.81	3.14	.22
Liver	18.58[a]	15.58[b]	15.47[b]	.44
Pancreas	1.29	1.06	1.18	.08
Spleen	2.22	2.42	2.49	.29
Reticulorumen	22.66[a]	24.22[b]	24.38[b]	.48
Omasum	7.61[a]	8.36[a]	14.14[b]	1.41
Abomasum	3.92	4.52	4.82	.29

Small intestine	16.97	17.55	18.28	.97
Large intestine	11.00	11.54	11.00	.68
Cecum	1.05	1.92	1.34	.27
Mesenteric fat	27.83[a]	16.06[b]	7.78[c]	2.06
Total GIT[d]	63.21[a]	68.10[ab]	73.93[b]	2.20
Total splanchnic[e]	110.90[a]	100.80[ab]	98.35[b]	3.40

[a,b,c]Means in a row without a common superscript differ (P<.05).
[d]Reticulorumen, omasum, abomasum, small intestine, large intestine and cecum
[e]GIT, liver, pancreas, and mesenteric fat

Final Empty Organ Mass. Final EBW of steers at slaughter was 31.2 and 27.0 kg less (P<.05) in LGW steers than HGW and NR steers (Table 2). Weights of total gastro-intestinal and total splanchnic tissue did not differ between treatments. This may be explained by the fact that all steers were harvested at the same backfat or physiological endpoint. High gain wheat steers which had greater (P<.05) mesenteric fat at the initial harvest date and NR steers had greater (P<.05) mesenteric fat at the final harvest than LGW steers.

Table 2. Final organ and tissue weights of steers (g/kg of empty body weight)

Tissue	HGW	LGW	NR	SEM
Empty body weight, kg	531.58[a]	500.78[b]	527.81[a]	7.34
Total offal	1100.12	1109.26	1100.56	7.19
Hide	71.16	70.21	75.87	3.60
Blood	30.96	29.84	29.72	1.54
Head	29.55	31.25	30.42	.69
Feet and ears	22.62	23.67	22.40	.63
Trim	13.811	16.03	16.98	1.74
Heart	4.29	4.48	4.31	.20
Lung	13.58	14.86	14.29	.75
Kidney	2.10[a]	1.97[ab]	1.88[b]	.05
Liver	15.10	14.62	14.85	.46
Pancreas	.87	.93	1.02	.06
Spleen	1.95	2.46	2.12	.26
Reticulorumen	23.28	23.88	21.62	.74
Omasum	9.06	9.75	10.67	.89
Abomasum	3.09	3.84	2.70	.39
Small intestine	13.30	12.95	12.95	.48
Large intestine	9.76	10.77	9.48	.49
Cecum	14.43	1.56	1.76	.13
Mesenteric fat	37.25[a]	28.79[b]	35.02[a]	2.19
Total GIT[d]	59.91	62.74	59.17	1.78
Total splanchnic[e]	113.13	107.08	110.06	3.10

[a,b,c]Means in a row without a common superscript differ (P<.05).
[d]Reticulorumen, omasum, abomasum, small intestine, large intestine and cecum
[e]GIT, liver, pancreas, and mesenteric fat

Daily Organ Accretion Rate. We calculated daily organ accretion rate as the change in tissue mass from initial harvest to final harvest on a per day basis. Rate of EBW gain did not differ between the three treatments, and averaged 1.78 kg/d (Table 3). Total offal accretion was also not different, increasing by 0.5 g/kg of EBW per day. The rate of daily liver mass change was greater ($P<.05$) in HGW steers than either LGW or NR steers. In all steers, the liver became a smaller portion of the EBW with increasing days on feed. Mesenteric fat increased in all treatments. The accretion rate of mesenteric fat was greater ($P<.05$) in NR steers than LGW steers. Initial mesenteric fat weight in NR steers was the lowest of the three treatments and, therefore, had the greatest rate of accretion. Reticulorumen EBW change was greater ($P<.05$) in HGW steers than NR steers with LGW steers being intermediate. Reticulorumen mass in HGW steers increased during the finishing period whereas reticulorumen mass in LGW and NR steers became a smaller portion of the EBW. Decrease in total GIT tissue (g/kg EBW) was greatest ($P<.05$) in NR steers. Initial total GIT (g/kg EBW) of NR steers was greater than either wheat treatment because of the large amount of low-quality forage that they would have consumed during the grazing phase. Likewise, in LGW steers the decrease in total GIT was greater than HGW steers because initial total GIT mass of LGW steers was greater. Total splanchnic tissue (g/kg EBW) change was not different between the three treatments. The lack of difference was because liver weight decrease in HGW steers was greatest, and total GIT change the least; whereas, in NR steers, liver weight decrease was the least and total GIT change the greatest. Low gain wheat steers were intermediate for both liver and total GIT weight changes.

Table 3. Change in organ and tissue mass of steers (g/kg of empty body weight per day)

Tissue	HGW	LGW	NR	SEM
Empty body weight, kg	1.768	1.753	1.806	.048
Total offal	-.410[a]	-.045[b]	-.33[a]	.065
Hide	.014	-.051	.036	.029
Blood	-.075	-.061	-.056	.013
Head	-.052[a]	-.075[b]	-.028[c]	.005
Feet and ears	-.036[a]	-.069[b]	-.067[b]	.005
Trim	-.035[a]	.031[b]	.038[b]	.014
Heart	-.006	-.001	-.003	.002
Lung	.021[a]	.005[b]	-.001[b]	.007
Kidney	-.011[a]	-.007[b]	-.008[b]	.0004
Liver	-.038[a]	-.008[b]	-.004[b]	.004
Pancreas	-.005[a]	-.001[b]	-.001[b]	.001
Spleen	-.003	0.0	-.002	.002
Reticulorumen	.007[a]	-.003[b]	-.016[b]	.006
Omasum	.016[a]	.011[a]	-.021[b]	.007
Abomasum	-.009	-.005	-.013	.003
Small intestine	-.040	-.037	-.032	.004
Large intestine	-.014	-.006	-.009	.004
Cecum	.004[a]	-.003[b]	.003[b]	.001
Mesenteric fat	.104[a]	.101[a]	.163[b]	.019
Total GIT[d]	-.036[a]	-.043[b]	-.088[c]	.015
Total splanchnic[e]	.024	.050	.070	.028

[a,b,c]Means in a row without a common superscript differ ($P<.05$).
[d]Reticulorumen, omasum, abomasum, small intestine, large intestine and cecum
[e]GIT, liver, pancreas, and mesenteric fat

Implications

Several other researchers have reported that level of nutrition can affect organ mass. Organ mass then dictates the maintenance energy requirements of those organs. If maintenance energy requirements of splanchnic tissues can be reduced, then energy available for gain would be increased and animal performance improved. This was the case in that steers that had reduced liveweight gains during winter grazing showed compensatory gains during the feedlot phase. Compensatory gains in these cattle may have been brought about by the reduced organ weights of metabolically active organs.

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