Carcass Compositional Changes and Nutrient Efficiency of Steers as Affected by Size, Age or Biological Type

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Story in Brief

Angus and Charolais weanling steers were fed either a control or restricted growing ration for 306 days (older steers) or 95 days (younger steers). Steers were then switched to a high energy finishing ration (80 percent concentrate). Representative steers from each breed, treatment and age subgroup were slaughtered initially and at the end of the growing and finishing phases to determine carcass composition and nutrient efficiency data. The older control Angus steers yielded leaner carcasses when compared to other treatment groups at the end of the finishing period. Few differences were noted in Charolais carcasses due to age or treatment. Younger steers were more efficient in conversion of dry matter and metabolizable energy to live weight gain and in conversion of metabolizable energy to carcass energy. From a practical viewpoint, small-framed, fast maturing cattle should be used in a system for growing the cattle on a forage ration up to about 700-800 lb before placing them on a high concentrate ration. If placed in the feedlot at a light weight, either because of age or near-maintenance nutritional level, they fatten too quickly, and the final carcass composition could exceed 30 percent fat. Charolais cattle, on the other hand, should be placed in the feedlot as early as possible to facilitate finishing quality grade, but some trade-off in efficiency may be encountered.

Introduction

The physiological causes of compensatory growth and the composition of that growth have not been satisfactorily explained. It is generally accepted that the conditions under which the animal is subjected to nutrient restriction (age, severity and duration of restriction, genetic type, etc.) have a profound influence on the animal's ability to compensate. Further, it is now recognized that changes in carcass composition can be accomplished with nutrition as well as genetics and that the two may interact. The objectives of this study were to determine the influence of size, age and carcass composition on the rate and composition of gain of different biological types of cattle following a period of restricted feeding or adequate energy intake.

This work was a cooperative effort between USDA-ARS, Southern Region, Southwestern Livestock and Forage Research Station, El Reno, and OSU Animal Science Department.

Materials and Methods

The overall design was described by Coleman and Evans (1982). Slaughter groups were taken at the initation of the study (6 steers per breed-age), during the switch from the growing to finishing diets (6 steers per treatment-breed-age), and after the cattle finished (6 steers per treatment-breed-age). All steers were weighed (after a 16-hr shrink) and transported to the Oklahoma State University Meat Laboratory where they were penned overnight without feed and water and slaughtered the following morning. Each steer was weighed immediately prior to slaughter. Reticulo-rumen and omasum contents were weighed and subtracted from pre-slaughter live weight to determine empty body weight.

The right side of each carcass was physically separated into bone, soft tissue, and kidney and pelvic fat. After the soft tissue was ground and mixed, two 10-lb samples were removed. These samples were again ground and mixed. Four samples (.5 lb) were then taken, homogenized using a Sorvall Omnimixer, frozen and stored at -20 C while awaiting chemical analysis. Proximate analysis procedures (A.O.A.C., 1975) were used to determine percent moisture, protein, ether extract and ash of the carcass soft tissue. Gross energy was calculated using equations reported by Garrett and Hinman (1969).

Results and Discussion

Growing Phase

Weight changes and gains of various tissues are presented in Table 1. Daily protein gain, fat gain and, consequently, energy gain were greater for the control vs restricted steers within age groups of both breeds. Further, the older Charolais steers deposited more protein and less fat than the older Angus steers within treatment level. However, energy gain was not different ($P>.05$) among breed.

Control steers were more efficient in utilizing metabolizable energy for liveweight gain (Table 2) than the respective restricted groups within breed and age ($P<.05$). In addition, the younger Angus steers were more efficient than the older Angus steers. This can be attributed to the shorter duration of the growing phase. A reverse trend occurred in the Charolais steers. This difference is credited to the younger steers having lost weight early in the experiment and not to a true difference between the two breeds. The older control steers of both breeds and the Charolais younger control steers were more efficient than their restricted subgroups in converting metabolizable energy intake (MEI) to carcass energy gained. The younger Angus steers were similar in efficiency (10.7 Mcal MEI/Mcal gain) across treatments, which is probably associated with their shorter growing phase.

The Angus and Charolais steers differed in the efficiency of utilization of digestible protein intake (DPI). The younger Angus steers were more efficient than the older steers (4.1 vs 11.1g DPI/g protein gain), but no difference was observed for the Charolais steers (10.3 g DPI/g protein gain).

Finishing phase

Rate of daily energy gain ($P<.05$) and protein gain ($P=.10$) in the carcass was greater for the older steers than for the younger steers (Table 3). While no difference was observed in the Charolais steers ($P>.2$) due to treatment, the control Angus steers had an increased rate of protein gain ($P=.07$) when compared to the restricted Angus steers (122.7 vs 86.9 g protein/day, respectively) (Table 4). Fat deposition (g/day) was similar ($P>.1$) for all steers. There was a

Table 1. Effect of breed, treatment and age on weight gain and components of carcass gain of steers during the growing phase[a]

	Angus				Charolais				
	Older		Younger		Older		Younger		
Item	C[b]	R[b]	C	R	C	R	C	R	SEM[c]
Initial weight, lb (kg)	378 (172)	356 (162)	321 (146)	317 (144)	507 (231)	494 (225)	537 (244)	608 (276)	27 (12)
Final weight, lb (kg)	796 (362)	491 (223)	471 (214)	328 (172)	1038 (472)	690 (314)	696 (316)	617 (280)	16 (8)
Number of days on feed	314	330	108	208	291	289	82	83	8
Average daily gain, lb (kg)	1.36 (.62)	.35 (.16)	1.28 (.58)	.51 (.23)	1.85 (.84)	.66 (.30)	1.36 (.62)	.35 (.16)	.09 (.04)
Protein gain[d], g/day	57.4	24.0	87.7	42.5	94.8	32.8	68.7	3.8	4.64
Fat gain[d], g/day	132.1	15.9	62.5	32.4	110.4	10.2	78.9	18.4	2.79
Energy gain[d], Mcal/day	1.56	0.28	1.07	0.54	1.56	0.20	1.12	0.19	0.05

[a]Least square means; number of observations/mean = 12.
[b]C = control growing ration; R = restricted growing ration.
[c]SEM = standard error of the mean.
[d]Carcass compostitional changes are based on hot carcass weight.

Table 2. Effect of breed, treatment and age on feed, energy and protein efficiency of steers during the growing phase[a]

	Angus				Charolais				
	Older		Younger		Older		Younger		
Item	C[b]	R[b]	C	R	C	R	C	R	SEM[c]
MEI[d], Mcal	17.71	9.45	11.71	5.86	20.18	12.54	16.15	8.19	.39
MEI, Mcal/live weight gain, kg	22.82	70.36	17.17	51.38	18.35	40.85	21.00	43.84	25.07
MEI, Mcal/carcass gain, gain, Mcal	10.01	33.74	11.26	10.14	11.54	48.79	13.29	49.41	14.77
DPI[e], g/day	795.2	223.3	525.5	173.4	905.8	292.7	725.2	235.3	15.15
DPI, g/carcass protein gain, g	12.83	9.33	4.96	3.28	8.68	9.36	10.04	13.20	2.58

[a]Least square means; number of observations/mean = 12.
[b]C = control growing ration; R = restricted growing ration.
[c]SEM = standard error of the mean.
[d]MEI = metabolizable energy intake.
[e]DPI = digestible protein intake.

trend, however, towards an increased fat deposition rate for the older steers vs the younger steers and for the older restricted steers vs the older control steers. These results support data of Byers and Rompala (1979) which indicated an increase in fat deposition with increased ADG but contrasts their observation of greater rates of protein gain with larger vs smaller-frame steers.

Metabolizable energy (ME) efficiency for liveweight gain was greater for the younger steers of both breeds ($P<.05$) (Table 3). The restricted Charolais steers required less ME per unit of live weight gain than Charolais control steers ($P<.01$) (Table 4). No differences occurred due to treatment for the Angus steers ($P>.1$). These results indicate that dry matter and energy utilization, as measured by live weight gains, are dependent on animal age and that younger steers are more efficient. Two factors need to be considered here: first, the younger steers had a lower average daily weight during the finishing period and, therefore, a lower maintenance requirement; second, the gain of the younger steers (especially the Angus) contained less energy. As a result, the difference in efficiency observed on the basis of live weight gain does not occur when efficiency is expressed on an

Table 3. Effect of age on components of carcass gain and energy efficiency of steers during the finishing phase[a]

Item	Older	Younger	SEM[b]
Protein gain[c], g/day	110.5	96.9	4.77
Fat gain[c], g/day	391.6	345.9	18.84
Energy gain[c], Mcal/day	4.287[e]	3.782[f]	0.161
MEI[d], Mcal/day	26.34	21.83	.70
MEI, Mcal/live weight gain, kg	22.25	20.11	.47
MEI, Mcal/carcass gain, Mcal	7.10	6.01	.44

[a]Least square means; number of observations/mean = 24.
[b]SEM = standard error of the mean.
[c]Changes based on hot carcass weight.
[d]MEI = metabolizable energy intake.
[ef]Means in the same row with different superscripts are different ($P<.05$).

Table 4. Effect of breed and treatment on feed and energy and protein efficiency of steers during the finishing phase[a]

	Angus		Charolais		
Item	C[b]	R[b]	C	R	SEM[c]
MEI[d], Mcal/day	23.88	21.41	27.19	23.86	2.04
MEI, Mcal/live weight gain, kg	20.45[fg]	20.76[f]	24.07[g]	19.44[f]	1.36
MEI, Mcal/carcass gain, Mcal	6.17	5.26	8.80	5.99	1.27
DPI[e], g/day	592.5	531.2	671.9	589.0	50.8
DPI, g/carcass protein gain, kg	5.17[f]	6.45[g]	6.69[fg]	6.50[fg]	0.52
Conversion of DPI for gain[e], %	40.21[f]	30.67[g]	29.47[fg]	34.07[fg]	3.40

[a]Least square means; number of observations/mean = 12.
[b]C = control growing ration; R = restricted growing ration.
[c]SEM = standard error of the mean.
[d]MEI = metabolizable energy intake.
[e]DPI = digestible protein intake.
[fg]Means in the same row with different superscripts are different ($P<.05$).

Table 5. Body compositon based on hot carcass weight of steers slaughtered initially and at the end of the growing and finishing phases[a]

	Angus				Charolais				
	Older		Younger		Older		Younger		SEM[b]
Initial									
Hot carcass weight, lb (kg)	88.9		75.2		122.5		149.7		9.11
Moisture, %	79.5		70.2		78.7		72.3		3.29
Fat[c], %	5.6		8.3		4.8		3.6		1.01
Protein, %	19.5		19.8		20.0		20.5		0.15
Ash %	1.0		1.0		1.0		1.0		0.01
Treatment level	**C[d]**	**R[d]**	**C**	**R**	**C**	**R**	**C**	**R**	**SEM**
End of growing phase									
Hot carcass weight, lb (kg)	261.7	109.6	112.7	89.9	280.9	176.6	188.5	151.5	7.28
Moisture, %	60.9	77.2	73.9	74.1	68.8	78.0	76.4	78.7	1.16
Fat, %	21.4	7.7	10.0	9.3	13.6	5.1	6.5	4.5	1.13
Protein, %	16.1	18.7	19.2	18.9	18.7	19.5	20.4	20.2	0.40
Ash, %	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.01
End of finishing phase									
Hot carcass weight, lb (kg)	295.2	274.6	271.8	232.6	402.4	386.7	352.4	372.0	6.11
Moisture, %	55.4	49.0	50.2	50.3	62.4	59.2	62.2	61.9	1.31
Fat, %	28.7	35.6	34.9	33.8	20.2	24.3	21.3	21.5	1.45
Protein, %	15.3	14.5	14.4	15.2	17.7	16.9	17.2	17.5	0.40
Ash, %	0.8	0.7	0.7	0.8	0.8	0.9	0.9	1.0	0.03

[a]Number of observation/mean = 6
[b]SEM = standard error of the mean.
[c]Fat content was determined from ether extract procedure (A.O.A.C., 1975).
[d]C = control growing ration; R = restricted growing ration.

energy basis (Mcal intake/MCal gain). These results further indicate that efficiency was not affected by previous plane of nutrition in the small-frame steers.

Metabolizable energy required per Mcal carcass gain, however, did not differ for any breed, treatment or age subgroup (P>.05). A trend (non-significant P>.05) was observed for the restricted Charolais steers to be more efficient. The fact that no significant differences occurred when comparing energy efficiency for carcass energy gain suggests differences in the composition of the gain. Therefore, energy utilization may be more accurately compared among groups by considering the composition of the gain and not weight gain alone.

Daily digestible protein intake (DPI) was greater (P<.05) for older steers than younger steers (651.6 vs 540.7 g/day). Protein efficiency, as measured by DPI per unit of protein gain and by the conversion of digestible crude protein for protein gain above maintenance (%), was not different (P>.05) due to treatment or age within the Charolais breed (Table 4). These results agree with results of Fox et al. (1972) where no difference in protein efficiency above maintenance (%) was observed between compensatory and control Hereford steers slaughtered at 454 kg. However, Angus control steers were more efficient according to both these efficiency measurements than their restricted counterparts. No difference (P>.05) occurred in protein efficiency due to age.

Carcass composition

Carcass composition of all slaughter groups is presented in Table 5. Little differences occurred among the initial weaning calves. However, after the growing phase, carcass composition reflected the treatments in that those fed the control ration for a long period of time were fatter. Also, Angus were fatter than Charolais as expected. Little difference occurred between older restricted and younger controls, which is similar to results reported by Burton and Reid (1969) that size, not age, is the predominate factor in determining body composition. However, the rankings had reversed at final slaughter, and older Angus cattle which had been grown at the higher level finished with less total carcass fat at a higher carcass weight than the other groups. This suggests that fast maturing cattle are more suited to a scheme of production utilizing a period of backgrounding or forage feeding up to approximately 700-800 lb before placing them in the feedlot. However, few differences in carcass composition of Charolais were noted at final slaughter. Older-restricted steers tended to be slightly fatter. Most of the Charolais were slaughtered with less backfat than the Angus, but logistically it was not practical to keep them until they reached .5 in backfat, to which the Angus were carried. Charolais and similar slow-maturing cattle should be placed in the feedlot as quickly as possible to facilitate finishing rather than growing.

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