Effect of Age, Size and Biological Type on Feedlot Performance of Steers Following Two Planes of Nutrition

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Story in Brief

The objective of this experiment was to determine the effect of two levels of nutrition for two durations during the growing phase on subsequent performance of steers during the finishing phase. Angus and Charolais weanling steers were fed either a moderate (control) or restricted growing ration for 306 days (older steers) or 95 days (younger steers). Steers were then switched onto a high energy finishing ration (80 percent concentrate).

Compensatory growth was observed in the older restricted steers when compared to the older control steers during the first part of the finishing phase for Charolais but not for Angus. Dry matter efficiency followed a similar trend in that the Charolais restricted steers were more efficient than their controls, but no differences were observed in the Angus steers. Growth rates for the growing and finishing phases combined were greater for the younger than the older steers. Further, the younger steers were more efficient in conversion of dry matter and metabolizable energy for live weight gain. From a practical viewpoint, holding steers on a growing ration for a long period of time offers no advantage in overall rate of gain or nutrient efficiency. When steers were held on a growing ration for a shorter period of time on either level of nutrition, no differences were seen in nutrient efficiency for live weight or carcass gain.

Introduction

During recent years, the need for more efficient and economical beef production has become increasingly apparent to the beef cattle industry. When cereal grain prices increase, the producer seeks alternative methods of feeding cattle and often looks toward higher roughage feeding programs. This means of reducing his costs must be weighed, however, against the increased inventory time necessary for the cattle to reach the final endpoint. In the post weaning segment of production it is believed that calves which enter the feedlot after being grown on a relatively low plane of nutrition will gain faster than calves reared on a high plane of nutrition, other factors being equal.

Data from many experiments support the phenomenon of compensatory growth. However, the physiological cause of the accelerated growth has not been

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satisfactorily explained since the conditions under which the animal is subjected to the nutrient restriction (age, severity and duration of the restriction, genetic type, etc.) influence the animal's ability to compensate.

The objective of this study was to determine the effect of a low vs moderate growing diet on rate of gain and nutrient efficiency of steers during the subsequent finishing period. The design allowed for the evaluation of the effect of animal age and animal weight at the end of this period on successive performance. Steers entering the finishing phase were either of equal weight but different ages or of different weight but the same age. Further, two breeds were used to evaluate the effect of frame size (large frame, late maturing vs small frame, early maturing steers) in conjuction with age and size on steer performance.

Materials and Methods

A 2 x 2 x 2 factorial design which included age, resulting from the duration of the growing phase (older vs younger); biological type (large frame vs small frame); and plane of nutrition during the growing phase (control vs restricted) was used. Thirty-four spring-born weanling Angus steers and thirty-four Charolais steers purchased in November, 1978, represented the older steers. An equal number of fall-born steers of each breed were purchased from the same producers in June, 1979, and represented the younger steers. The Angus steers were representative of the small frame, early maturing biological type, and the Charolais steers were representative of the large frame, late maturing type. All steers were maintained in confinement pens (2 animals per pen) at the Southwestern Livestock and Forage Research Station, El Reno, Oklahoma.

Growing phase

Twelve older and 12 younger steers of each biological type were stratified based on weight, height at the withers and ultrasonic backfat thickness to one of three reps. Within each rep, the calves were randomly allotted to either the control or the restricted growing ration for a final distribution of six animals per treatment-type-age subgroup. Those calves on the control ration were fed pelleted dehydrated alfalfa ad libitum. Gains of approximately .75 kg per day were expected. The restricted steers were limit fed a ration which had a digestible energy content of 81.8 Mcal/kg. Adjustments were made in the amount of the ration fed until average daily gains of approximately .2 kg per day were attained. Ration composition, chemical analyses and nutrient values are described in Table 1.

The steers were weighed onto trial and at 28-day intervals following a 16-hour shrink without feed and water. The growing phase was terminated for each rep when the younger steers fed the control growing ration reached approximately the same weight as the older steers fed the restricted ration. At this point, half of the steers (six animals) of each treatment were slaughtered, and the remaining steers were switched to a high concentrate finishing ration (Table 2). A schematic drawing of the design of the experiment is in Figure 1.

Finishing phase

During the first, second and third weeks of the finishing phase, the steers were fed a 50:50, 60:40 and 70:30 concentrate:roughage ration, respectively. Beginning the fourth week and for the remainder of the experiment, all steers received a typical 80 percent concentrate ration (Table 1), fed ad libitum.

The final slaughter point was determined by ultrasonic measurement of backfat thickness. Angus steers were slaughtered at 12 mm backfat and Charolais steers at 8 mm backfat.

Table 1. Ingredients and chemical analysis of the rations

Item	IRN[a]	Growing Ration		Finishing ration[b]
		Control	Restricted	
Ingredients		(%)		
Alfalfa hay	1-00-059		13.0	10.0
Dehydrated alfalfa pellets	1-00-023	100.0		
Cracked shelled corn	4-02-931			70.3
Soybean meal	5-04-604		10.0	3.9
Cottonseed hulls	1-01-599		45.0	10.0
Mixed grass hay	1-02-244		19.0	
Wheat straw	1-05-175		13.0	
Molasses	4-04-696			5.0
Salt				0.6
Calcium carbonate				0.2
Proximate analysis[c]				
Dry matter, %		92.6	93.5	87.6
Organic matter, %		89.5	93.6	95.3
Crude protein, %		17.2	10.1	10.8
Neutral detergent fiber, %		50.5	75.4	30.1
Energy, Mcal/lb		2.2	1.8	2.0
Digestible protein, %		9.4	4.7	7.4
Digestible energy, Mcal/lb		1.2	.8	1.5
Metabolizable energy, Mcal/lb		1.0	.7	1.3

[a]International reference number.
[b]Finishing ration contains 250 mg monensin per ton.
[c]All components except % dry matter are expressed on a dry matter basis.

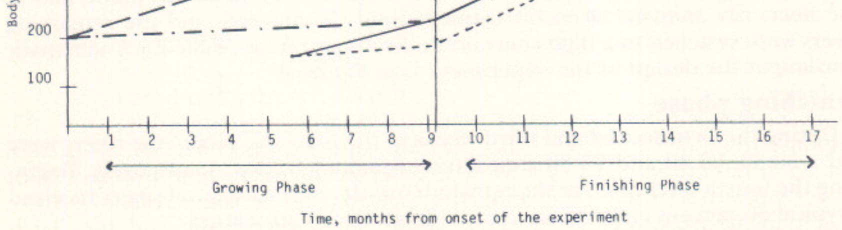

Figure 1. Basic design of the experiment with regard to nutrient level, animal age and duration of the growing and finishing phases

Results and Discussion

Growing phase

The objective of the growing phase was to create differences in body weight and/or composition due to breed, treatment and age in order to determine their effect on steer performance during the subsequent finishing phase. Average daily gains (ADG) during this period directly reflected the energy level of the diets as the control steers gained significantly faster than the restricted steers within their respective breed/age subgroup (Table 2). Final weight was greater ($P<.05$) for the older control steers within both breeds (Angus, 361.8; Charolais, 471.7 kg), but weight was similar for the older restricted and younger control steers ($P>.05$) as was predetermined in the design of the experiment. The younger restricted steers were the lightest groups within breed. On the average, Charolais steers remained in the growing phase longer than the Angus steers (215 vs 186 days), and the older steers were on trial longer than the younger steers (306 vs 95 days).

Finishing phase

Live weight performance of all steers during the finishing phase is presented in Table 3. At the onset of this phase, the older control steers were heavier ($P<.05$) than the other three sub-groups with both breeds, and the older restricted and younger controls were similar in weight. At the end of the finishing phase (12 mm backfat for Angus steers; 8 mm backfat for Charolais steers) the Charolais steers were heavier ($P<.05$) than the Angus steers, and the older steers within each breed were heavier ($P<.05$) than the younger steers. In addition, the older control steers required less time to reach the final endpoint ($P<.05$) than did the other sub-groups within a breed, as was expected due to their heavier weight at the beginning of the finishing phase.

Average daily gain (ADG) did not differ due to breed but was greater ($P<.05$) for the older steers than the younger steers (1.25 vs 1.10 kg). When comparing ADG among the groups of steers, however, one environmental factor must be considered. Just after the first group of steers reached the final endpoint and were slaughtered, several weeks of very cold and wet weather conditions prevailed, resulting in a period of maintenance for about 45 days. This resulted in a decrease in ADG of the remaining steers from that time until their respective time of slaughter. Therefore, it is necessary to compare ADG during the finishing phase in two periods: from the onset until the first group was slaughtered, and from that time until the remaining steers were slaughtered (Table 4). During the first period, the Angus and Charolais older restricted and younger control steers, which entered the finishing phase at similar weights within breed, showed no difference ($P>.05$) in ADG.

These results support those of Coleman et al. (1976) which indicated that feedlot gains were independent of animal age and of previous plane of nutrition and are closely related to animal weights upon entering the finishing phase. The older, restricted Charolais steers exhibited a compensatory growth ($P<.05$) response when compared with their control counterparts (1.54 vs 1.25 kg/day), but no difference in ADG ($P=.57$) was observed between these two groups of Angus steers (restricted 1.65; control, 1.59 kg/day). The compensatory growth seen in the Charolais steers is similar to results from other studies with both large frame steers (Drori et al., 1974) and with smaller frame steers (Fox et al., 1972) but is in contrast with results of Levy et al. (1971) where Israeli-Friesian bull calves (large frame) failed to show compensatory growth following a restricted period.

Table 2. Effect of breed, age and treatment on weight gain of steers during the growing phase

	Angus				Charolais				
	Older		Younger		Older		Younger		
Item	C[b]	R[b]	C	R	C	R	C	R	SEM[c]
Initial weight, lb	379	356	321	317	507	494	493	608	59
Final weight, lb	796	491	471	378	1038	690	696	617	36
Days on feed	314	330	108	108	291	289	82	83	8
Average daily gain, lb	1.36	.35	1.28	0.51	1.85	0.66	1.36	0.35	0.19

[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.

Table 3. Effect of breed, age and treatment on weight gain of steers during the finishing phase[a]

	Angus				Charolais				
	Older		Younger		Older		Younger		
Item	C[b]	R[b]	C	R	C	R	C	R	SEM[c]
Inital weight, lb	838	488	492	380	1043	660	649	636	
Final weight, lb	954[d]	927[d]	839[e]	819[e]	1468[f]	1437[f]	1303[g]	1362[g]	101
Number of days on feed	58[d]	182[e]	160[e]	202[e]	163[f]	279[g]	260[g]	269[g]	12
Average daily gain, lb	2.84[d]	2.49[d]	2.31[e]	2.18[e]	2.84[d]	2.82[d]	2.51[e]	2.68[e]	0.63

[a]Least square means; number of observations/mean = 6.
[b]C = control growing ration; R = restricted growing ration.
[c]SEM = standard error of the mean.
[d,e,f,g]Means in the same row with different superscripts are different ($P<.05$).

Table 4. Effect of breed, age and treatment on weight gain of steers before and after the first group was slaughtered during the finishing phase[a]

	Angus				Charolais				
	Older		Younger		Older		Younger		
Item	C[b]	R[b]	C	R	C	R	C	R	SEM[c]
Days to first slaughter	34[e]	61[f]	32[e]	84[f]	121[g]	154[h]	133[gh]	140[gh]	13
ADG to first slaughter lb/day	3.50[e]	3.63[e]	3.70[e]	2.57[f]	2.75[f]	3.39[e]	3.34[e]	3.28[e]	0.39
Days after first slaughter	....	121	128	118	89	124	126	130	13
ADG after first slaughter lb/day	....	1.91	1.82	1.85	1.80	1.94	1.56	1.94	0.92

[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]ADG = average daily gain.
[e,f,g,h]Means in the same row with different superscripts are different ($P<.05$).

The results of the Angus steers, however, conflict with those previously mentioned for smaller frame steers. A possible explanation is that the older control steers may have also been exhibiting compensatory growth following the growing phase, since they were not growing to their maximum potential on the pelleted alfalfa diet.

Reasons for the compensatory growth observed in the Charolais but not the Angus steers are not apparent. Periods of energy restriction in larger frame steers generally have not resulted in compensatory growth since the composition of the gain is unaltered (Levy et al., 1971); but in smaller frame steers, a restriction was associated with an increase in protein and water accumulation (Fox et al., 1972) and a resulting decrease in fat deposition during the subsequent refeeding period and thus increased ADG.

Table 5. Effect of breed, treatment on feed and energy efficiency of steers during the finishing phase[a]

	Angus		Charolais		
Item	C[b]	R[b]	C	R	SEM[c]
DMI[d], lb/day	18.1	16.1	20.4	17.8	3.4
DMI, % body weight	2.35	2.47	1.80	1.69	.22
DMI, lb/live weight gain, lb	7.04[fg]	7.09[f]	8.21[g]	6.61[g]	.47
MEI[e], Mcal/day	23.88	21.41	27.19	23.86	2.04
MEI, Mcal/live weight gain, lb	9.3[fg]	9.4[f]	10.9[g]	8.8[f]	0.28

[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]DMI = dry matter intake.
[e]MEI = metabolizable energy intake.
[f,g]Means in the same row with different superscripts are different ($P<.05$).

The older steers consumed more dry matter per day during the finishing phase ($P<.05$) than the younger steers of either breed (Table 6). However, most of the increase was the result of animal size. When intake was divided by metabolic body size, the differences were not significant ($P>.05$). The compensatory growth response observed in the older restricted Charolais steers was not, therefore, due to an increase in dry matter intake, but to an increase ($P<.05$) in utilization.

Dry matter efficiency for liveweight gain was greater for the younger steers of both breeds ($P<.05$) throughout the feedlot phase. Within the Angus steers, there was no difference in dry matter efficiency (Table 6) for any treatment group. In

Table 6. Effect of age on feed and energy efficiency of steers during the entire finishing phase[a]

Item	Older	Younger	SEM
DMI[c], lb/day	19.8[e]	16.4[f]	1.2
DMI, % body weight	2.07	2.07	.02
DMI, lb/live weight gain, lb	7.61[e]	6.86[f]	.16
MEI[d], Mcal/day	26.34[e]	21.83[f]	.70
MEI, Mcal/live weight gain, lb	10.1[e]	9.1[f]	.10

[a]Least square means; number of observations/mean = 12.
[b]SEM = standard error of the mean.
[c]DMI = dry matter intake.
[d]MEI = metabolizable energy intake.
[e,f]Means in the same row with different superscripts are different ($P<.05$).

contrast, the restricted Charolais steers were more efficient than their controls (P<.01), suggesting not only compensatory gain for the Charolais steers (during the early part of the finishing phase) but compensatory efficiency as well. Metabolizable energy (ME) efficiency for live weight gain followed the same trend as did dry matter efficiency during the finishing phase. The younger steers were more efficient (P<.05) than the older steers, and the restricted Charolais steers required less ME per unit of live weight gain than the control steers (P<.01). No differences occurred due to treatment for the Angus steers (P>.10). The younger steers had a lower average weight during the finishing period and, therefore, a lower maintenance requirement.

These results further indicate that efficiency was not affected by previous plane of nutrition in the small frame steers, which supports results of Coleman et al. (1976) with crossbred steers. Restricting the larger frame steers resulted in greater efficiency during the feedlot phase similar to work by Levy et al. (1971) and Fox et al. (1972).

Carcass parameters

Slaughter data for steers at the end of the finishing phase, adjusted to a constant backfat thickness, are presented in Table 7. Charolais steers were heavier than the Angus steers, and the control steers were heavier than the restricted steers. No differences (P>.05) were observed in hot dressing percent or rib eye area due to breed or treatment although the Charolais steers did tend to have larger rib eyes. In addition, quality grade was higher for older steers than for younger steers.

Table 7. Effect of breed and age on carcass characteristics of steers at the end of the finishing phase[a]

	Angus		Charolais		
Item	Older	Younger	Older	Younger	SEM[c]
Slaughter weight, lb	930[d]	819[e]	1353[f]	1276[g]	105
Hot carcass weight, lb	600[d]	541[e]	881[f]	833[g]	51
Hot dressing percent	64.38	65.78	65.18	65.37	1.14
Backfat thickness, in.	.61	.54	.31	.28	.03
Rib eye area, in.^{2}	1.89	1.74	2.39	2.37	.01
Quality grade[c]	13.5[d]	12.3[e]	12.4[d]	11.2[e]	0.6

[a]Least square means (backfat thickness is the actual measurement); number of observations/mean = 12.
[b]SEM = standard error of the mean.
[c]10 = average good; 13 = average choice; 16 = average prime.
[d,e,f]Means in the same row with different superscripts are different (P<.05).

Growing and finishing phases combined

The older restricted steers of both breeds had the lowest (P<.05) ADG of any age and treatment group for the growing and finishing phases combined. As a result, they were on the experiment longer (P<.05) than any other group. The time required from the onset of the study to final slaughter was similar for the younger control and restricted steers of both breeds. Within treatment, the older Angus steers, which had equal gains and energy efficiencies during the finishing phase, had lower ADG and a greater length of time on trial than the younger Angus steers. Similar results have been reported, both in studies where compensatory growth was observed (Fox et al., 1972) and not observed (Levy et al., 1971). No difference was observed in ADG for the Angus and Charolais steers within the control group. Within the restricted steers, daily gains of Angus were lower than those of Charolais steers. Therefore, while no difference due to breed occurred with control steers, small frame steers were more adversely affected by the restriction than were larger frame steers.

The results indicate that nutrient restriction for a short period of time may not affect overall steer performance, especially in the larger frame steers. Longer periods of restriction will lead to an increased inventory time which may more than offset any increased efficiency of steers exhibiting compensatory gain during the finishing period. Thus, even if compensatory gains can be expected, overall profitability of the production scheme is questionable. Producers may take advantage of the compensatory growth response when attempting to make more efficient utilization of forages or homegrown grains where availability is influenced by season, rainfall, temperature, etc. But, more commonly, the compensatory growth phenomenon is used when different owners are involved in the growing and finishing phases, and then by one at the expense of the other.

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