Growth performance and carcass composition in beef heifers undergoing catch-up (compensatory) growth

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Yambayamba, E. and Price, M. A. 1991. **Growth performance and carcass composition in beef heifers undergoing catch-up (compensatory) growth.** Can. J. Anim. Sci. **71**: 1021–1029. Fifty-three Hereford crossbred heifers (211±28 (mean±SD) kg; 197±13 d of age at day 1) were used to study catch-up growth and its effects on carcass composition. Five heifers were slaughtered on day 1; the remaining 48 were randomly penned in groups of six and assigned to treatments as follows: three pens to ad libitum feeding (target gain >1.0 kg d^{-1}); three pens to 2 mo of feed restriction (target gain 0.5 kg d^{-1}); followed by realimentation; and two pens to 4 mo of feed restriction (target gain: 2 mo at 0.5 kg d^{-1} and 2 mo at 0.0 kg d^{-1}) followed by realimentation. Animals from one pen were slaughtered from each treatment after 2 mo, after 4 mo, and at a final slaughter weight of about 410 kg. During the final period (4 mo to slaughter), growth rate was greater ($P<0.05$) in the 4-mo than in the 2-mo restricted–realimented animals or the ad-libitum-fed animals (1.91 vs. 1.18 vs. 1.02 kg d^{-1}), respectively. Feed restriction for 2 mo had no significant effect on the composition of the three-rib cut, but 4 mo of feed restriction was associated with significantly lower and higher ($P<0.05$) proportions of fat and bone, respectively, in the three-rib cut. Muscle proportion was not affected by treatment. At the final slaughter weight, no significant differences were found among treatments in the tissue proportions of the three-rib cut. It is concluded that 2 or 4 mo of feed restriction, starting at 6 mo of age, has no permanent effect on a heifer's live weight or body composition.

Key words: Heifers, feed restriction, realimentation, compensatory growth, carcass composition

Yambayamba, E. et Price, M. A. 1991. **Croissance et composition de la carcasse chez des génisses à viande exposées à des conditions de croissance de rattrapage.** Can. J. Anim. Sci. **71**: 1021–1029. Cinquante-trois génisses Hereford croisées, pesant en moyenne 211±28 kg et âgées de 197±13 jours au premier jour de l'expérience (jour 1) ont servi à une étude sur la croissance de compensation et sur les effets sur la composition de la carcasse. Cinq génisses étaient abattues au jour 1, les 48 autres étant réparties au hasard par groupes de 6 entre les traitements suivants: trois parquets en alimentation à volonté (gain visé > 1 kg/jour), trois lots exposés à 2 mois de rationnement (gain visé 0,5 kg/jour) suivis d'un retour en alimentation à volonté, et deux lots passant par 4 mois de rationnement (gain visé 0,5/kg pour les 2 premiers mois et 0 kg pour les 2 derniers mois) suivis d'un retour à l'alimentation à volonté. À l'intérieur de chaque traitement, un lot était abattu à la fin du deuxième et du 4ième mois ainsi qu'au poids marchand final d'environ 410 kg. Durant la période finale (4 mois à poids marchand) la croissance était plus rapide ($P<0,05$) chez les animaux rationnés pendant 4 mois que dans le groupe rationné pendant 2 mois ou dans celui alimenté sans restriction (1,91 contre 1,18 contre 1,02 kg/jour). Deux mois de rationnement n'ont pas eu d'effet sur la composition du morceau de trois côtes, mais 4 mois ont donné lieu à des proportions respectives significativement plus basses et plus fortes ($P<0,05$) de gras et d'os dans ce morceau. La proportion de muscle n'était pas touchée. Au poids marchand d'abattage final, la composition du morceau des trois côtes était la même quel que soit le traitement. On peut en déduire qu'un rationnement de deux à 4 mois à partir de l'âge de 6 mois n'a pas d'effet négatif permanent sur le poids vif ni sur la composition de la carcasse des génisses.

Mots clés: Génisses, rationnement, retour à l'alimentation à volonté, croissance de compensation, composition de la carcasse

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Catch-up growth, sometimes referred to as "compensatory growth," may be defined as the acceleration in growth that occurs when a period of growth inhibition ends and favourable conditions are restored (Ashworth and Millward 1986). It is essentially a self-correcting response which restores the individual to its original growth curve. This is of practical use in the beef industry, where, for example, certain feedlots commonly buy underfed steers, knowing they will catch up rapidly and efficiently.

Although different aspects of catch-up growth in livestock have been investigated, the major concern has been its effects on the carcass composition of castrated male animals destined for meat production. Very little attention has been paid to young growing female livestock, although Marchello et al. (1979) and Graham and Price (1982) have reported the results of realimenting range-fed cows and heifers culled from the breeding herd. A commonly expressed concern among cattle producers is that underfed heifer calves will be "stunted," with a tendency to dystocia. Growth theory indicates that this would be so only if underfeeding interfered with hyperplasia in the various tissues and organs.

The objective of this study was to test the hypothesis that feed restriction of heifers at about 6 mo of age and lasting for 2 or 4 mo would have no permanent effect on live weight or body composiiton.

MATERIALS AND METHODS

Animals

Fifty-four unimplemented Hereford crossbred heifers (intermediate frame size, muscular, and propensity to fatten) born in April and May 1988 at the University of Alberta Ranch at Kinsella were used in this experiment. They were weaned in October of the same year and transported 150 km by road to Ellerslie Research Station near Edmonton, where the study was conducted.

The heifers were housed in open-fronted concrete floored sheds bedded with wood shavings. A 25-d period of adjustment to the medium DE, barley–alfalfa based experimental diet (Table 1) was allowed before the experiment was started on 7 Nov. 1988 (day 1). On day 1 they weighed 211±28 (mean± SD) kg and were 197±13 d of age. During the adjustment period, one heifer died of bloat and was not replaced.

Table 1. Composition of the experimental diet as feed

	Composition of diet (g kg^{-1})
Barley grain	754.5
Alfalfa grass hay	200.0
Canola meal	30.0
Calcium carbonate	8.0
Salt, fortified	5.0
Vitamin ADE	2.5
Nutrient composition	
Dry matter (DM), %	84.6
Crude protein, % of DM	13.1
DE (MJ kg^{-1} DM)	13.8

Experimental Design

Five heifers were selected at random and slaughtered on day 1 (INIT) to establish initial body composition. The remaining 48 were penned in groups of 6 and randomly assigned to treatments as follows (Fig. 1): three pens to ad libitum access feed (ADLIB); three pens to 2 mo of feed restriction (target gain: 2 mo at 0.5 kg d^{-1}) followed by ad libitum (2REST); two pens to 4 mo of feed restriction (target gain: 2 mo at 0.5 kg d^{-1} and 2 mo at 0.0 kg d^{-1}) followed by ad libitum (4REST).

At day 62 (2 mo) and day 119 (4 mo), the animals in one pen from each group were slaughtered (Fig. 1). Animals in the remaining three pens were fed ad libitum from day 119 until the average live weight for the pen reached 410 kg (market weight), when all six heifers in the pen were slaughtered. The experiment was thus divided into three periods: days 1–62 (period 1), days 62–119 (period 2), and day 119 to market weight (period 3).

Feeding, Slaughter, and Determination of Carcass Composition

The animals were fed daily between 09:00 and 10:00 h and had access to water at all times. The ad-libitum-fed animals had continual access to feed, while the restricted animals were fed only to achieve their target gain. Feed intake for each pen was recorded daily and individual live weights weekly. The daily ration (i.e., amount fed) was adjusted as necessary to maintain target gain.

On the day before slaughter, the animals were fasted and trucked about 15 km to a commercial packing plant in Edmonton for slaughter in the normal commercial manner. The dressed carcasses were shrouded and chilled (1–3°C) overnight and

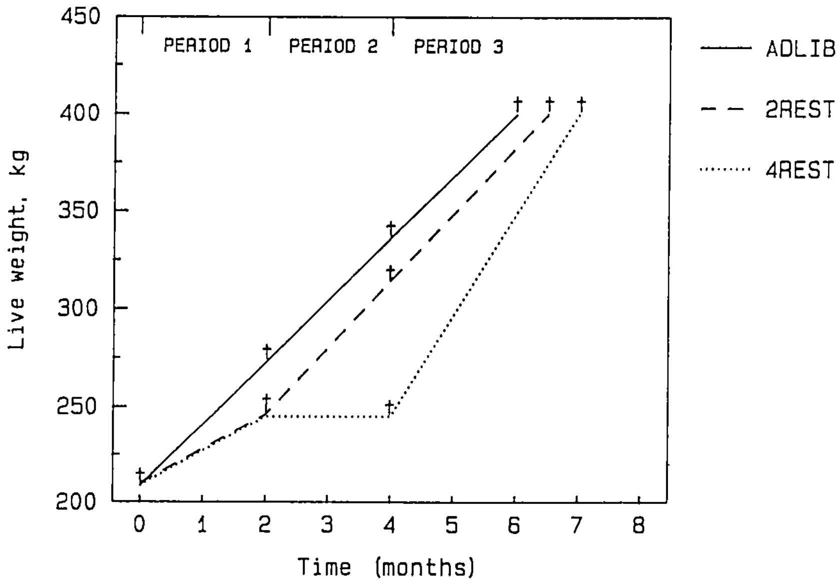

Fig.1. Schematic representation of the experimental design; †, slaughter group of five or six heifers.

the shrouds were removed the following morning. The left side of each carcass was quartered between the 12th and 13th ribs, and the 10-11-12th rib piece was removed by an experienced technician to ensure uniformity. The piece was trimmed according to the method described by Hankins and Howe (1946), before physical separation into muscle, bone, and fat. Briefly, the method requires removal of the plate from the rib portion of the three-rib piece with a cut parallel to the chine and 61.5% of the distance from the chine to the "button" of the 13th rib cartilage. Through a communication error at the end of period 1, data from two of the ADLIB and two of the 2REST carcasses were unusable for estimating body composition.

Statistical Analysis

Individual regressions of live weight on time within each period were recorded as rate of gain. Individual tissue weights were computed as proportions of the total tissue weight in each three-rib cut. The data were analyzed by a two-way analysis of variance (Harvey 1960), using a fixed model:

$$Y_{ijk} = \mu + F_i + T_j + FT_{ij} + E_{k(ij)}$$

where:

Y_{ijk} = three-rib cut carcass component for each individual,

F_i = feeding treatment,

T_j = time period,

FT_{ij} = feeding treatment × time period interaction,

$E_{k(ij)}$ = random error term.

The Student–Newman–Keuls (SNK) procedure was used to separate the means when significant ($P<0.05$) main effects were found.

Logarithms of each three-rib cut weight and all its component weights were computed to allow allometric analysis (Huxley 1932). The three-rib cut components were then regressed on three-rib cut weight from the start of realimentation for each treatment, and regressions were compared using either the t-test (ADLIB vs. 2REST, considered over three periods) or the SNK range test (comparing all three treatments over the last two periods).

RESULTS

Gain and Feed Consumption

The ADLIB heifers exhibited a steadily declining growth rate and feed efficiency as the study progressed (Table 2). During realimentation the 2REST group showed a similar pattern, with an initially high growth rate and feed efficiency following removal of the restriction, but declined in both during the

Table 2. Daily gain, feed intake, and feed efficiency of heifers before and after being fed ad libitum (ADLIB) or following 2 mo (2REST) or 4 mo (4REST) of feed restriction

	ADLIB				2REST				4REST			
Period	n	Daily gain (kg)	Feed intake (kg/animal)	Feed efficiency (gain/feed)	n	Daily gain (kg)	Feed intake (kg/animal)	Feed efficiency (gain/feed)	n	Daily gain (kg)	Feed intake (kg/animal)	Feed efficiency (gain/feed)
Days 1–62	3	1.23	7.4	0.17	3	0.50	3.5	–	2	0.49	3.5	–
Days 62–119	2	1.14	8.0	0.14	2	1.32	7.0	0.19	2	0.00	2.9	–
Days 119 – market wt[z]	1	1.02	8.0	0.12	1	1.18	8.9	0.13	1	1.91	9.5	0.20
Total feed intake			1358				1363				1383	

[z] Average live weight for pen of about 410 kg. n = number of pens.

third period. The 4REST group, which experienced the longest and most severe feed restriction (zero gain in the second period), achieved the highest gains and feed efficiencies of any group once the restriction was removed. The total feed intake per animal for the whole experimental period was 1358, 1363, and 1383 kg for the ADLIB, 2REST, and 4REST heifers, respectively. Since there was only one pen for each treatment in period 3 (4 mo to market weight), no statistical analysis of these data is possible.

Carcass Composition

Dissection of the three-rib cut showed no significant differences among restricted, ad-libitum-fed, and initial groups in either absolute or relative weight of any of the major carcass tissues or in the muscle to fat ratios at the end of period 1 (Table 3). However, the muscle to bone ratios in the three-rib cuts of the ADLIB heifers were greater ($P<0.05$) than in the INIT or 2REST group.

Four months of feed restriction (periods 1 and 2), however, resulted in significant reductions in the absolute weights of muscle and fat compared with full feeding or 2 mo of restriction followed by ad libitum feeding (Table 4). Feed treatments had no significant effect on the weight of bone. The amount of muscle in the three-rib cut of the ADLIB and 2REST animals had increased significantly over the second period (during which the 2REST animals were fed ad libitum), while that in the 4REST animals had significantly decreased and was actually less ($P<0.05$) than in the INIT animals. The amount of fat in the three-rib cut of the ADLIB and 2REST animals had significantly increased ($P<0.05$) and that in the 4REST animals had decreased, though not significantly, during period 2. There was no treatment effect on three-rib cut bone weight.

Expressed as a proportion of the three-rib cut weight, muscle was unaffected ($P>0.05$) by the 4REST feeding regimen (Table 4). The proportion of bone in the three-rib cut of the 4REST group was similar to that in the INIT group but was higher ($P<0.05$) than that in the ADLIB and 2REST heifers. Fat, being the

Table 3. Least-squares means (± SE) of the major carcass tissue weights and proportions in the three-rib cuts of heifers before (INIT) and after being fed an ad libitum (ADLIB) or restricted (2REST) ration for 2 mo

	INIT	ADLIB	2REST	*P*
No. of animals	5	4	4	
Slaughter age (d)	199±4*a*	255±5*b*	254±5*b*	0.001
Slaughter wt (kg)	211±17*a*	296±23*b*	246±12*b*	0.02
Three-rib cut wt (g)	1637±219	1900±198	1447±147	0.35
Muscle wt (g)	915±130	1084±93	826±83	0.21
Bone wt (g)	386±22	352±34	339±25	0.55
Total fat wt (g)	335±100	464±88	281±44	0.27
Muscle (g kg^{-1})[z]	559±21	574±16	572±1	0.75
Bone (g kg^{-1})[z]	249±30	188±13	237±13	0.11
Total fat (g kg^{-1})[z]	197±30	238±28	191±14	0.43
Muscle:bone ratio	2.4±4.1*a*	31±2*b*	2.4±0.1*a*	0.04
Muscle:fat ratio	3.1±0.6	2.6±0.4	3.0±0.2	0.59

[z]Expressed as a proportion of the three-rib cut weight.
*a,b*Means within a row followed by a different letter differ significantly ($P<0.05$).

Table 4. Least-squares means (± SE) of the major carcass tissue weights and proportions in the three-rib cuts of heifers before (INIT) and after being fed an ad libitum for 4 mo (ADLIB), restricted for 2 mo and realimented for 2 mo (2REST) or restricted for 4 mo (4REST)

	INIT	ADLIB	2REST	4REST	*P*
No. of animals	5	6	6	6	
Slaughter age (d)	199±4*a*	315±4*b*	317±5*b*	311±5*b*	0.001
Slaughter wt (kg)	211±17*a*	343±4*b*	314±7*b*	244±12*a*	0.001
Three-rib cut wt (g)	1637±219*a*	2640±153*b*	2289±143*b*	1416±122*a*	0.001
Muscle wt (g)	915±130*b*	1307±78*c*	1184±77*c*	820±63*a*	0.001
Bone wt (g)	386±22	430±18	426±13	402±32	0.58
Total fat wt (g)	335±100*a*	908±78*b*	678±108*b*	239±41*a*	0.001
Muscle (g kg^{-1})[z]	559±21	496±13	521±28	564±19	0.12
Bone (g kg^{-1})[z]	244±30*b*	165±15*a*	190±12*a*	277±14*b*	0.001
Total fat (g kg^{-1})[z]	197±41*a*	339±15*b*	289±32*b*	158±17*a*	0.001
Muscle:bone	2.4±0.3*a*	3.0±0.2*b*	2.8±0.2*b*	2.1±0.1*a*	0.01
Muscle:fat	3.1±0.6*a*	1.5±0.1*b*	2.0±0.3*b*	3.8±0.6*a*	0.002

[z]Expressed as a proportion of the three-rib cut weight.
*a,b,c*Means within a row followed by a different letter differ significantly ($P<0.05$).

most variable tissue in the carcass, has an important influence on the proportions of the other two tissues. During period 2, the proportion of fat in the ADLIB heifers increased by over 42% (from 238 to 339 g kg^{-1}), while in the 2REST animals, which also had ad libitum access to feed at that time, it increased by over 51% (from 191 to 289 g kg^{-1}). At the same time, the percentage of muscle and percentage of bone decreased.

The muscle to bone ratio in the three-rib cut of the ADLIB and 2REST heifers at the end of period 2 was larger ($P<0.05$) than in the INIT or 4REST animals (Table 4). On the other hand, the muscle to fat ratio was smaller $P<0.05$) in the ADLIB and 2REST heifers than in the INIT or 4REST groups.

After full feeding to a market weight of about 410 kg, the amounts of bone and fat in the three-rib cut were similar in all treatments (Table 5), whereas the weight of muscle in the 4REST cattle was lower ($P<0.05$) than that in the 2REST animals; the amount of muscle in the ADLIB group, however, was not significantly different from either of the other two treatments. The differences in the three-rib cut

Table 5. Least-squares means (± SE) of the major carcass tissue weights and proportions in the three-rib cuts of heifers after ad libitum feeding (ADLIB) or following 2 mo (2REST) or 4 mo (4REST) of feed restriction to a market weight of about 410 kg

	ADLIB	2REST	4REST	P
No. of animals	6	6	6	
Slaughter age (d)	373±8*a*	401±5*b*	422±7*c*	0.001
Slaughter wt (kg)	414±19	419±13	408±13	0.88
Three-rib cut wt (g)	3002±118	3220±160	2933±102	0.45
Muscle wt (g)	1477±59*ab*	1738±144*b*	1328±19*a*	0.02
Bone wt (g)	492±22	549±39	500±15	0.30
Total fat wt (g)	1034±81	1002±80	1105±104	0.71
Muscle (g kg^{-1})^z	494±19	526±23	456±20	0.10
Bone (g kg^{-1})^z	164±5	167±9	171±5	0.74
Total fat (g kg^{-1})^z	342±18	307±28	373±24	0.18
Muscle:bone	3.0±0.2	3.2±0.2	2.7±0.1	0.07
Muscle:fat	1.5±0.1	1.8±0.2	1.3±0.2	0.15

^{z}Expressed as a proportion of the three-rib cut weight.
*a,b*Means within a row followed by a different letter differ significantly ($P<0.05$).

muscle content indicate that full compensation had not occurred by the time a weight of 410 kg was achieved.

Significant Interaction Effects

There were some significant treatment × period interactions for the proportions of the major carcass tissues and muscle to bone ratios in the three-rib cut. The proportion of muscle in the three-rib cut of the ADLIB and 2REST animals was similar (496 and 521 g kg^{-1}, respectively) at the end of period 2 (Table 4) and remained so in period 3. The proportion of muscle in the 4REST three-rib cut decreased from 564 g kg^{-1} at the end of period 2 (Table 4) to 456 g kg^{-1} at the end of the experiment (Table 5), although, overall, this ultimate proportion was not significantly different from those in the other treatments. The proportions of bone and fat in the three-rib cut of the ADLIB and 2REST animals were similar at the end of period 2 (Table 4) and remained relatively constant up to the end of the experiment (Table 5). On the other hand, the proportion of bone was significantly higher and the proportion of fat significantly lower in the 4REST animals at the end of period 2. The proportions of bone and fat significantly decreased and increased, respectively, when the 4REST animals were refed in period 3. The muscle to bone ratio also remained relatively constant in the ADLIB and 2REST animals, but decreased significantly in the 4REST animals, during period 3 (Table 5).

Allometry

Comparison of the allometric growth coefficients of the ADLIB and 2REST animals during the period when both groups had ad libitum access to feed (from the beginning of period 2 to the end of period 3) revealed that the

Table 6. Allometric relationships between the three-rib cut tissue weights and the three-rib cut weights of heifers from two feed treatments slaughtered at the end of periods 1, 2, and 3

	ADLIB (n = 16)			2REST (n = 16)			Probability of difference in b
	a	b	R^2	a	b	R^2	
Muscle wt	0.7	0.71±0.1	0.85	0.04	0.91±0.1	0.91	0.04
Bone wt	0.4	0.66±0.1	0.72	0.80	0.56±0.1	0.78	0.23
Fat wt	−3.2	1.79±0.1	0.92	−2.40	1.55±0.2	0.88	0.13

Table 7. Allometric relationship between the three-rib cut tissue weights and the three-rib cut weights of heifers from three feed treatments slaughtered at the end of periods 2 and 3

	ADLIB (n = 12)			2REST (n = 12)			4REST (n = 12)			Probability of difference in b
	a	b	R^2	a	b	R^2	a	b	R^2	
Muscle wt	0.2	0.80±0.2	0.71	−0.3	1.00±0.2	0.80	0.7	0.7 ±0.1	0.92	0.33
Bone wt	0.6	0.59±0.2	0.44	0.7	0.57±0.2	0.55	1.4	0.38±0.1	0.70	0.60
Fat wt	−2.0	1.45±0.2*a*	0.81	−1.6	1.32±0.2*a*	0.64	−4.6	2.22±0.1*b*	0.97	0.02

*a,b*Means within a row followed by a different letter differ significantly ($P<0.05$).

muscle in the three-rib cut was growing at a relatively faster ($P=0.04$) rate in the latter than in the former (Table 6). No significant differences in the relative growth of bone or fat were found between the two treatments. A similar comparison among all three feed treatment groups during period 3 (when all had ad libitum access to feed) showed that relative fat accumulation was greater ($P<0.05$) in the 4REST than in the ADLIB or 2REST heifers (Table 7). The relative growth of bone and muscle was similar among treatments during this period.

DISCUSSION

Gain and Feed Efficiency

The results of this study indicate that a period of underfeeding is followed by a period of catch-up in both gain and feed efficiency, the rate of catch-up being greater when following a longer and more severe restriction. Wilson and Osbourn (1960) suggested that longer and more severe feed restriction would result in slower recovery than shorter or less severe restriction. Though the present data do not support that hypothesis, the restrictions applied in this study were neither long nor extreme like those reported by Wilson and Osbourn (1960). Conversely, Ashworth and Milward (1986) stated that complete catch-up can occur even in situations where growth retardation has been extremely severe or prolonged, a conclusion supported by the present data.

Physiologically, when an animal is underfed there is a deviation from the normal physiological:chronological time relationship, the former proceeding at a relatively slower rate (Koch 1982). Refeeding of such animals may therefore accelerate the growth rate in order to rebalance the physiological:chronological relationship. In the present study, the rate of gain during catch-up was greater for the more severely restricted group, in agreement with that principle. There is no evidence from the present study that the capacity of the heifers to resume normal growth was impaired in any way. In fact, the suggestion by Winchester and Howe (1955) and Heinemann and Van Keuren (1956) that cattle of at least 5 mo of age can overcome periods of feed restriction varying in both severity and duration can safely be applied.

The present data indicate that increased feed consumption and efficiency are associated with catch-up growth and that the overall feed requirement to achieve 410 kg live weight was similar whether or not the heifers experienced a period of feed restriction. Similar results have been reported by Hidiroglou et al. (1987) in Brahman cattle. Saubidet and Verde (1976), in an experiment with steers, found that the greater the severity of feed restriction, the higher the realimentation feed intake at equal weight. Clearly, as confirmed in the present study, the more severe the feed restriction, the greater the tendency to compensate by consuming more feed. These findings also agree with those of Hironaka and Kozub (1973) and Turgeon et al. (1986) but do not agree with those of Foot and Tulloh (1977), who found that the mean total intake of refed steers was 12% less than that of the control steers. However, in that study the cattle recovered to the same weight relative to age as the control group. Generally, feed efficiency (gain:feed) and growth rate are strongly positively related, a trend clearly observed in this study.

Carcass Composition

During the periods of feed restriction there were relative decreases in the weight of both muscle and fat in the three-rib cut, but no such effect on the weight of the bone. Price (1976) found similar results in early- and late-fattening steers. His study showed a significant increase in the percentage of bone during feed restriction, indicating the relative stability of bone weight even during undernutrition, as shown in the present study. In the present experiment, two different patterns of tissue recovery were observed during catch-up. Following the shorter period of restriction, muscle of 2REST animals showed the greater impetus for growth, but following the longer period of restriction, fat of 4REST animals showed the greater impetus. Joubert (1954) suggested that the rapid increase in weight that follows retardation may simply be due to the replacement of lost fat, and that this process may take place more rapidly than true growth. This is contrary to Berg and Butterfield's (1976) observation that realimentation results in an increase in muscle mass towards a point of normal muscle to bone relationship, while the recovery of fat is given lower priority. Comparison of muscle weights at the end of periods 2 and 3 (Tables 4 and 5) in the present study indicates that both groups of realimented heifers were achieving very rapid muscle growth during the third period. The similarity in the fat content of the three-rib cut at market weight (Table 5) suggests that fat had compensated more quickly than muscle weight, supporting the suggestions of Joubert (1954). The growth coefficients found in the allometric analysis of the data (Tables 6 and 7) confirm the suggestion that the 2REST animals placed priority on rebalancing the muscle to bone relationship whereas the 4REST animals placed a high priority on accumulating fat. This difference in the pattern of recovery was not expected, and cannot be considered conclusive, given the limitations of a sample joint method of assessing carcass composition; further investigation is warranted.

The treatment effects on the weight and proportion of bone in the three-rib cut at the final slaughter weight were as expected. Bone is little influenced by nutritional treatment (Murray et al. 1974; Price 1976) and is more closely associated with age than with differences in plane of nutrition. In the present study, the animals slaughtered at the end of each period were of the same age and therefore it is expected that bone weight in the three-rib cut would be similar in all treatments. However, at the final slaughter weight, the 2REST and 4REST animals were 28 and 49 d older, respectively, than the ADLIB animals, though this was not sufficient to cause any significant effect on bone weight.

CONCLUSION

It is concluded that heifers weaned at 6 mo and restricted to little or no gain for up to 4 mo can fully recover both live weight and body composition if subsequently offered adequate nutrition, probably at no extra feed cost. This information may be of value in decision making in cases where early weaning and backgrounding of feeder calves is being practiced or planned, but reluctance to risk "stunting" of potential breeding cows inhibits the early weaning and restricted feeding of heifers. These findings could also be an aid to decision making in circumstances where feed availability is either severely limited or seasonal. In those cases it is often difficult for managers to decide on the highest priority classes of cattle to feed. Potential breeding cows may receive, as calves, a higher priority for available feed than is necessary.

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