EFFECT OF FEED RESTRICTION AND REALIMENTATION ON NUTRIENT UTILIZATION AND CARCASS COMPOSITION OF ZEBU BULLS.

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ABSTRACT

Forty-eight Sokoto Gudali bulls were used to study carcass compositional changes and nutrient efficiency following feed restriction (25% ad libitum feeding, L., and 54% ad libitum feeding, M) and realimentation (ad libitum feeding, H). The treatments were designated as LLH, LMH and LHH according to the level of feeding for each of three periods within each treatment group. Representative bulls were slaughtered at the beginning of the study and at the end of each feeding period. At the end of the mid period, animals on the LLH and LMH feeding regimes had higher percentages of water, similar percentages of protein and ash but lower proportions of fat and energy compared to animals on the LHH feeding regime. Following realimentation in the final period carcass gains contained approximately 21.0, 15.0, 18.5% protein and 22.0, 31.0 and 29.6% fat for LLH, LMH and LHH bulls respectively. The LHH animals were more efficient in utilizing metabolizable energy for carcass energy gain than the LLH and LMH animals. Digestible crude protein (DCP) efficiency for carcass protein gain averaged 17.6, 26.2 and 35.4 g DCP/g protein gain for LLH, LMH and LHH bulls respectively. The results suggest that improved efficiency of protein utilization is largely responsible for compensatory carcass growth in zebu bulls.

Key word:- Realimentation, nutrient utilization, carcass composition, zebu bulls

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INTRODUCTION

Animals previously restricted in feed intake often compensate for a period of retardation by growing at relatively faster rates than their unrestricted counterparts when given liberal amounts of feed (Wilson and Osbourn, 1960). The implications of the concept of compensatory growth are very natural or improved pastures to feed livestock under grazing conditions. The decline in forage availability during the dry season imposes a period of growth restriction. The wet season that follows is a period of abundant forage supply and grazing animals gain body weights rapidly.

The composition of compensatory gain has been examined by several workers with conflicting results. Feed restriction followed by realimentation resulted in accumulation of more protein and water and less fat and energy when compared with continuous normal growth in cattle (Coleman et al., 1982; Baker et al., 1985) and in sheep (Drew and Reid 1975; McManus et al., 1972). On the contrary, Meyer and Clawson (1964) and Searle and Graham (1975) found that accelerated growth after a period of undernutrition was associated with high fat contents of carcass tissues.

There is also some disagreement concerning the causal involvement of efficiency of nutrient utilization in compensatory growth. Fox et al., (1972) and Thomas et al., (1982) found efficiency of metabolizable energy and protein utilization to be higher in steers during realimentation after a period of feed restriction than full-fed controls.

In contrast, the efficiency of utilization of digestible energy was similar for cattle that were on a full-fed regime throughout or on a restricted feeding regime prior to liberal feeding (Carroll et al., 1964; Hironaka et al., 1979).

TABLE 1: CHEMICAL COMPOSITION OF THE DIET (%)¹

	Concentrate ²	Hay
Dry matter (DM)	88.6	91.4
Crude protein	17.2	3.3
Neutral detergent fibre	41.7	74.5
Acid detergent fibre	22.7	54.9
Cellulose	16.1	44.0
Gross energy, Kcal/g DM	4.11	3.96

¹Values expressed on DM basis

²Consists of molasses (25.02), cottonseed cake (35.0%), palm kernel cake (15.0%), wheat bran (13.0%), Rice bran (19.0%), common salt (1.0%), Bonnemal (0.6%) and Vit-mineral mix (0.4%).

In Nigeria, traditional fattening of cattle for sale and or slaughter is commonly practised under feedlot conditions in cattle markets. A few large-scale feedlots exist in the country which purchase feedlot cattle of varying ages and body conditions for fattening. The rate and efficiency of gains of such animals would determined the profitability of the enterprise.

The objective of this study was to use various dietary feeding manipulations (viz. varying levels of feeding) to create different body conditions in feedlot cattle to study the phenomena of compensatory growth in two age categories of indigenous cattle. It was hoped this could guide feedlot operators in the country to determine which age and body condition of cattle to purchase for fattening in the dry season.

MATERIALS AND METHODS

Animals and design of Experiment

Forty-eight Sokoto Gudali bulls, consisting of 24 young (12-18 months) and 24 old (24-30 months) were used in the study. The young old animals averaged 185 and 255 kg respectively.

The bulls were confined to individual pens and fed the same diet consisting of 60% gamba (*Andropogon gayanus*) hay and 40% concentrate mixture (Table 1). The animals were fed hay with minimal concentrate supplement for 90 days (early period) to maintain body weight. The

young bulls were fed concentrate at 0.4% body weight and older bulls at 1.0% body weight. These levels which maintained body weight in the 90-day stabilisation period were designated as low (L). Thereafter, the animals were randomly assigned to three treatments in the mid period (91 to 180 days) according to the level of feeding viz, low (L), medium (M) and high (H). In the final period (181 to 270 days) all animals were fed on high plane. The treatment categories were thus designated as LLH, LMH and LHH for each of the three periods within each treatment group. At the low and medium levels of feeding, animals received approximately 25 and 45% of the intake of those on high plane (ad. libitum) feeding respectively. The ad. libitum fed group was offered enough concentrate and hay to ensure 15-20% feed refusal. Water and trace mineralized salt were supplied at all times. The bulls were fed twice daily, at 0800 and 1600 hours and their weights recorded at two weekly intervals.

Slaughter procedure and estimation of carcass composition

From each age group six bulls were slaughtered during the designated early period to determine initial carcass composition.

At the end of each subsequent period, three bulls per treatment per age group or a total of six bulls per treatment and nine bulls per age group were slaughtered to determine initial carcass composition. In all the slaughter periods, animals were killed after a 24 h feed and water withdrawal. Following slaughter the carcass was weighed, chilled for 24 h at 3 to 4°C and reweighed. The carcass was then sawn down the dorsal mid-line into two sides and the left half was physically separated into lean, fat and bone. The lean and fat were bulked (hereafter referred to as boneless carcass) and stored in a freezer for further procession.

The frozen boneless carcass was cut into small pieces, followed by grinding in a 1 1/2 horse power Cripto Meat Mincer, mode AE 22 (Crypto-pearless Limited, London), using a 0.32 cm plate once. During grinding small aliquot samples were removed as minced meat passed through the plate. To ensure representative smapling, 600-800 g smaples were taken throughout the entire grinding period and thoroughly mixed. The composite sample was wrapped and sealed in an airtight polyethylene bag, then frozen util required for chemical analysis.

TABLE 2: MEAN CHEMICAL COMPOSITION (DRY MATTER BASIS) OF THE BONELESS CARCASS OF BULLS BY FEEDING REGIME AND AGE ANIMAL AT VARIOUS TRIAL STAGES.

	Feeding Regime				Age		
	LHH	LMH	LLH	SED	Young	Old	SED
End of mid-period							
Boneless carcass weight, kg	43.7a	27.2b	25.2b	2.22	25.3d	38.7e	1.82
Water, %	66.3	71.9b	74.2c	0.91	70.1	71.4	0.74
Protein, %	22.9	24.5	22.6	0.96	24.7d	21.9c	0.78
Fat, %	11.5a	4.6b	3.6b	0.91	6.1	7.0	0.70
Ash, %	1.1	1.1	1.0	0.13	1.1	1.0	0.10
Gross energy, Kcal/g DM	6.4a	5.6b	5.5b	0.08	5.8	5.9	0.07
End of final period							
Boneless carcass weight, kg	61.7	50.0	51.9	2.04	50.1	58.9	1.73
Water, %	63.9	64.2	67.1	1.39	65.0	65.2	1.19
Protein, %	21.0	20.1	21.4	0.72	21.8d	19.8e	0.62
Fat, %	15.9	16.6	13.7	1.34	14.9	15.8	1.16
Ash, %	1.0	1.0	1.1	0.10	1.0	0.9	0.08
Gross energy, Kcal/g DM	6.8	6.9	6.7	0.10	6.7d	6.9e	0.08

The samples were thawed and freeze-dried for 24 h. Freeze-dried samples were ground in a kitchen blender into fine powder. During grinding dry ice chips (frozen CO₂ gas) were added to facilitate the grinding process and reduce frictional heating which might result in loss of energy.

The ground samples were stored in labelled plastic bottles, tightly capped and kept in a freezer for proximate analysis.

Nitrogen in feed and meat samples was determined by the Kjeldahl procedure (A.O.A.C., 1975). Gross energy of feed and meat samples was determined by combusting 1.2 g in a Galenkamp adiabatic autobomb calorimeter using benzoic acid standard. Meat samples were analysed for ether extract and ash according to A.O.A.C. (1975). Moisture content of meat samples was determined by freeze-drying. Feed samples were analysed for neutral detergent fibre, acid detergent fibre and cellulose by the procedures of Goering and Van Soest (1970).

Daily protein, fat and energy gains were determined from the difference between initial and final boneless carcass protein, fat and energy values. Boneless carcass protein, fat and energy values were obtained by multiplying boneless

carcass weight by carcass concentrations of protein, fat and energy. Initial carcass compositional values of the surviving bulls which were carried to the initial slaughter group as determined by Lofgreen and Garrett (1968).

The data were subjected to analysis of variance procedure (Stell and Torrie, 1960) and treatment means were compared using the Student's t-test.

RESULTS AND DISCUSSION

Chemical composition

At the end of the mid period, animals on the LLH and LMH feeding regimes which were restricted in feed intake had more water, less fat and energy but similar proportions of protein and ash in their boneless carcass compared to the full-fed LHH control bulls (Table 2). These results are in close agreement with those of Coleman et al. (1982) who observed that restricted-fed steers tended to have more moisture and protein but less fat in their carcasses than full-fed steers. Following realimentation in the final period there was no significant difference between feeding regimes in carcass chemical composition. However, animals on the

TABLE 3: COMPONENTS OF BONELESS CARCASS GAIN AT VARIOUS TRIAL STAGES.

	Feeding Regime				Age		
	LHH	LMH	LLH	SED	Young	Old	SED
Mid period							
Boneless carcass gain, g/day	64.8a	-10.2b	-22.0b	10.63	20.0c	41.7d	8.71
Protein gain, g/day	10.7a	-4.6b	-9.9b	2.46	-6.3c	3.8d	2.02
Fat gain, g/day	17.8a	0.5b	-1.1b	1.74	2.5c	8.9d	1.43
Energy gain, Mcal/day	1.25a	0.68b	0.64b	0.06	0.65c	1.06d	0.04
Final period							
Boneless carcass gain, g/day	102.3a	151.3b	174.3b	13.36	110.1c	175.1d	12.78
Protein gain, g/day	16.0a	22.6a	33.7b	3.68	22.1	26.0	3.13
Fat gain, g/day	28.3a	47.3b	40.9b	5.18	32.0c	45.6d	4.41
Energy gain, Mcal/day	2.76	2.29b	2.34b	0.10	2.16c	2.76d	0.08

LLH feeding regime which were most severely restricted tended to have higher percentages of water, protein and ash but lower fat and energy proportions in their carcasses compared to the LMH and LHH animals. Realimentation after a period of weight loss in sheep also led to more water and protein and less fat and energy than continuously full-fed controls (Burton et al., 1974; Drew and Reid, 1975).

The younger bulls had significantly greater protein percentages than older bulls during the mid period (Table 2). At the end of the final period, younger bulls maintained significantly higher protein percentages but had significantly lower energy values than the older bulls.

Components of carcass gain

During the mid period, boneless carcass weight increased at the rate of 65.0 g/day for full-fed LHH bulls but decreased at the rates of 10.0 and 22.0 g/day for restricted-fed LMH and LLH bulls respectively (Table 3). Although the bulls on the LMH and LLH feeding regimes were in positive energy balance during the same period, the LHH bulls gained considerably more fat and protein. These results indicate that body fat and protein are mobilized during feed restriction to meet the maintenance needs of animals. The animals on the LLH and LMH feeding regimes which were underfed for longer periods exhibited compensatory carcass growth during full feeding in the final period (Table 3). Daily

boneless carcass gains were higher in those groups than in the LHH animals that were restricted for a shorter period. The composition of carcass gain varied considerably between treatment groups. The gain contained approximately 21.0, 15.0, 18.5% protein and 22.0, 31.0, 29.6% fat for LLH, LMH, and LHH bulls respectively. Thus, the boneless carcass weight gains made by the most severely restricted and realimented LLH bulls were higher in protein and lower in fat compared with bulls on LMH and LHH feeding regimes. This observation agrees with the results of Swingle et al. (1979) and Fox et al. (1972). In the study by Fox et al. (1972), weight gains made by compensatory steers during the first part of the full feeding period were higher in protein and lower in fat than full-fed controls but were higher in fat and lower in protein than controls during the last part of the full feeding.

Daily protein, fat and energy gains in the carcass were greater (.05) in the older bulls than the younger bulls during the mid period (Table 3). During realimentation in the final period, older bulls maintained significantly higher rates of carcass fat and energy gains while the difference between age groups in protein gain was not significant.

Efficiency of energy and protein utilization

Data obtained during realimentation in the final period show that the bulls on the LLH feeding regime were more efficient in utilizing meta-

TABLE 4: EFFICIENCY OF ENERGY AND PROTEIN UTILIZATION DURING THE FINAL FULL FEEDING PERIOD.

	Feeding Regime				Age		
	LHH	LMH	LLH	SED	Young	Old	SED
ME intake, Ncal/day	16.33	15.87	15.32	0.68	15.60	16.08	0.53
ME/kg EBW gain	26.68a	24.95a	20.45b	1.43	23.04	25.01	1.16
ME?Mcal carcass1 enegy gain	6.05a	7.11b	7.66b	0.24	7.25d	5.96e	0.20
DCP intake, g/day	617.2	573.2	612.5	33.25	553.9d	648.0e	65.53
DCP/g carcass1 protein gain	35.39a	26.18b	17.55c	2.33	27.85	24.90	1.91

bolizable energy (ME) for empty body weight gain than those on the LMH and LHH feeding regimes (Table 4). The bulls on the LLH and LMH feeding regimes were however, less efficient than the control bulls on LHH feeding regime in converting ME intake to boneless carcass energy gain. Baker et al. (1985) found no difference between normal and compensatory growth in energy in efficiency for carcass energy deposition.

Animals on the LLH feeding regime which were the most severely restricted were the most efficient in converting digestible crude protein to carcass protein gain during the full feeding period (Table 4). This probably because in LHH and LMH animals where a relatively

greater proportion of the gain is fat, dietary nitrogen is utilized less efficiently due to greater nitrogen loss in deamination of the amino acids. Improved efficiency of protein utilization for carcass protein retention during compensatory growth has also been reported by other workers (Fox et al., 1972; Graham and Searle, 1979).

The older bulls required significantly less ($P < .05$) ME per unit of boneless carcass energy gain than the younger bulls (Table 4). This may be due to the fact that the gain of the younger bulls contained less energy at this period (Table 3). The lack of a significant difference between the younger and older bulls in efficiency of digestible crude protein utilization for carcass protein gain observed in this study (Table 4) agrees with the results of Coleman et al. (1982) who found no difference in protein efficiency attributable to age of steers.

In conclusion, the data show that boneless carcass weight gains made by realimentated bulls after a period of severe feed restriction contain higher proportions. The results suggest that increased efficiency of protein utilization is largely responsible for compensatory carcass growth response in Zebu bulls. Furthermore, the greater efficiency of feed energy utilization for empty body weight gain observed in the most severely restricted LLH group and in younger bulls during the full feeding period suggest lower cost of fattening for these animals. Thus, for fattening in the dry season, it would be advantageous to purchase younger bulls that have experienced severe undernutrition and are in poor body condition since these are more likely to achieve body weight gains in the feedlot at a cheaper cost.

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