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INFLUENCE OF NUTRIENT INTAKE ON GROWTH, DEVELOPMENT AND TESTICULAR HISTOLOGY OF PREPUBERTAL BRAHMAN BULLS

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SUMMARY

Nutritional insufficiency will delay the onset of puberty in cattle. Twelve prepubertal Brahman bulls were individually fed to gain at either a moderate (.2-.6 lb/hd/d; MG) or high (1.6-2.2 lb/hd/d; HG) rate. Body weight gain, hip height and scrotal circumference were decreased in MG bulls. Paired testis, paired epididymis and seminal vessicle weights were enhanced in HG bulls but weights of neuroendocrine tissues were not affected. Testicular morphology was also enhanced by increased nutrient intake. These data indicate that the physiological ages of the bulls were enhanced by a higher rate of gain.

INTRODUCTION

The objective of this study was to determine the effect of nutrient intake on growth patterns, tissue weights and testicular development.

PROCEDURES

Twelve half-sib prepubertal Brahman bulls (373 to 433 lb; 253 to 285 d of age) were randomly assigned, within age and weight pairs, to dietary treatment groups. Bulls were individually fed each morning to gain either .2 to .6 (moderate gain; MG) or 1.6 to 2.2 (high gain; HG) lb/hd/d. Body weights were measured weekly and hip height and scrotal circumference were measured every 56 days to monitor growth and sexual development. Semen was collected by electroejaculation. With the appearance of the first motile spermatozoa (FS) both bulls in an age x sire group were slaughtered. At slaughter, tissues were collected and weighed and carcass specific gravity was determined. Also a sample of testicular tissue was prepared for light microscopy and Leydig cell size, seminiferous tubule diameter and proportion of expanded seminiferous tubules determined.

RESULTS

Age at FS was 397±13 days-of-age for HG bulls, while FS was not detected in MG bulls, indicating that differences in physiological age were occurring due to the level of dietary intake. Actual average daily body weight gains were 1.9±.8 and .6±.2 lb/hd/d for HG and MG bulls, respectively. Increasing nutrient intake resulted in increased gains in body weight, hip height and scrotal circumference ($P<.001$; Table 1). As expected, the HG bulls had greater weight gains over the duration of the study. Long bone growth, as assessed by hip height, was enhanced in HG bulls. By the end of the study, HG bulls had increased in hip height almost twice as much as did the MG bulls (4.1±.3 in vs. 2.2±.3 in, respectively). Carcass specific gravity was measured as an indicator of total body fat and was not different ($P>.10$) between HG and MG bulls. Taken with the data for weight gain and increased hip height, these data indicate that the level of dietary energy intake influenced deposition of protein and long bone growth, but did not alter body fat.

Specific evaluation of the reproductive tissues indicated that supplying increased dietary energy enhanced development of the reproductive system. Scrotal circumference increased more rapidly in the HG bulls. By the end of the study, scrotal circumference was 1 inch greater in HG compared to MG bulls. Weights of the various reproductive tissues at slaughter were also influenced by the level of dietary energy intake (Table 2). Paired testis weight was increased 1.5-fold ($P<.01$), paired epididymal weight was increased 1.2-fold ($P<.04$) and seminal vessicle weight was increased 1.3-fold ($P<.05$) in HG compared to MG bulls. Although dietary energy intake influenced the weights of gonadal and accessory tissues, there were no effects ($P>.10$) on the weights of either the anterior pituitary gland or the median eminence.

Examining sections of testicular tissue under a light microscope revealed differences in histological development due to dietary energy intake (Table 3). Leydig cells were approximately 20% larger ($P<.08$) in HG compared to MG bulls (10.6±.6 and 8.6±.6 µm for HG and MG bulls, respectively). The width of the open seminiferous tubules tended ($P<.10$) to be greater in HG compared to MG bulls. Additionally, the proportion of open seminiferous tubules was increased ($P<.001$) by increased dietary energy intake. When a score combining open, partially open and closed seminiferous tubules was computed for the bulls, increased dietary energy was found to increase the proportion of open seminiferous tubules in HG compared to MG bulls.

The data obtained in this study indicates that the level of dietary energy intake influences the physiological age of Brahman bulls. Providing dietary energy to maintain average daily gains between 1.6 and 2.2 lb/d will enhance the onset of puberty (i.e. increase physiological age). Additionally, limiting dietary energy so gains were between .2 and .6 lb/d would delay the onset of puberty as demonstrated in this study by the lack of motile spermatozoa in the ejaculate, decreased growth and development of the reproductive system.

TABLE 1. INFLUENCE OF AGE AND DIETARY ENERGY INTAKE ON INCREASES IN BODY WEIGHT, HIP HEIGHT AND SCROTAL CIRCUMFERENCE[a]

	Initial Measurement	Days on feed 56	112	First Sperm
Body weight gain (lb)				
Moderate gain	404±10	38.8±16.2[d]	81.2±17.8[d]	91.7±16.2[d]
High gain	433±17	89.9±14.0[e]	146.5±15.1[e]	202.0±14.0[e]
Mean	420±14	64.4±10.6[f]	113.9±11.5[g]	147.0±10.6[h]
Increased hip height (in)				
Moderate gain	44.3±.3	1.4± .3	1.9± .4[d]	2.2±.3[d]
High gain	45.1±.4	1.8± .3	3.7± .3[e]	4.1±.3[e]
Mean	44.7±.3	1.6± .2	2.8± .2[g]	3.1±.2[g]
Increased scrotal circumference (in)				
Moderate gain	6.6±.2	1.2± .2	1.6± .2[d]	1.8±.2[d]
High gain	6.5±.1	1.5± .2	2.1± .2[e]	2.8±.2[e]
Mean	6.6±.2	1.3± .1[g]	1.8± .1[g]	2.3±.1[h]

[a]Values are LS mean ± SEM.
[b,c]Different superscripts within columns indicate differences due to energy intake (P<.001).
[d,e]Different superscripts within columns indicate differences due to energy intake (P<.05).
[f,g,h]Different superscripts within rows indicate differences due to age (P<.05).

TABLE 2. EFFECT OF DIETARY ENERGY INTAKE ON TISSUE WEIGHTS AT SLAUGHTER[a]

	Dietary energy	
	Moderate gain	High gain
Paired testis wt. (g)	112.3±13.9[b]	171.3±13.9[c]
Paired epididymal wt. (g)	20.7± 1.6[d]	25.7± 1.6[e]
Seminal vessicle wt. (g)	19.8± 1.8[d]	25.3± 1.8[e]
Median eminence wt. (mg)	68.0± .6	66.6± .6
Adenohypophyseal wt. (mg)	616±26	602±26

[a]Values are LS means ± SEM.
[b,c]Different superscripts within rows indicate differences due to energy intake (P<.01).
[d,e]Different superscripts within rows indicate differences due to energy intake (P<.05).

TABLE 3. INFLUENCE OF DIETARY ENERGY INTAKE ON TESTICULAR TESTOSTERONE, LEYDIG CELL SIZE, SEMINIFEROUS TUBULE DIAMETER AND SEMINIFEROUS TUBULE SCORE[a]

	Dietary energy	
	Moderate gain	High gain
Testicular testosterone (μg/g)	.81 ± 1.01[b]	3.48 ± .89[c]
Leydig cell size (μm)	8.6 ± .6[d]	10.6 ± .6[e]
Seminiferous tubule diameter (μm)	75.3 ± 6.9[f]	92.6 ±6.9[g]
Seminiferous tubule score[h]	2.2 ± .1[i]	1.7 ± .1[j]

[a]Values are LS Means ± SEM.
[b,c]Different superscripts within rows indicate differences due to dietary energy intake (P<.08).
[d,e]Different superscripts within rows indicate differences due to dietary energy intake (P<.05).
[f,g]Different superscripts within rows indicate differences due to dietary energy intake (P<.10).
[h]Score determined as the average of open tubules (1), partially opened tubules (2) and closed tubules (3).
[i,j]Different superscripts within rows indicate differences due to dietary energy uptake (P<.001).