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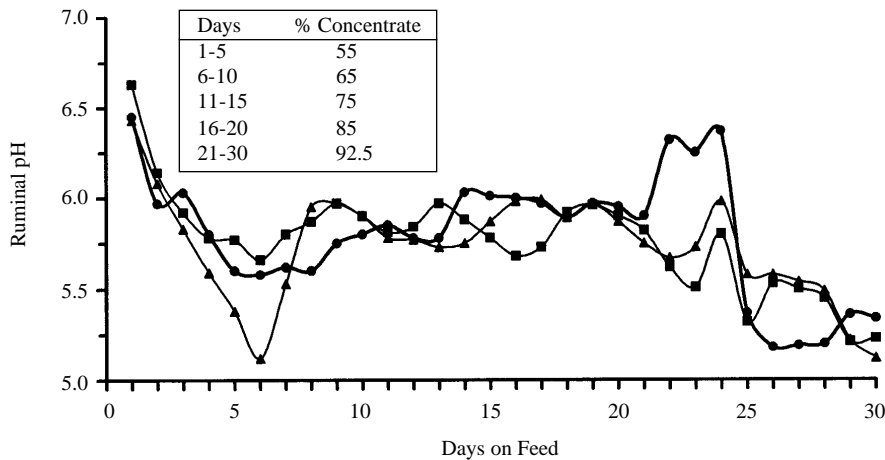


Figure 5. Average daily ruminal pH of three steers during grain adaptation.

however would encourage more rapid rates of intake, which can create acidosis even with diets relatively high in roughage, as shown in Figure 2.

Figure 5 shows another interesting anecdotal event which occurred during these steers' grain adaptation period. The figure shows that on day 24, average ruminal pH consistently increased for all three steers. On this day, a feeding mistake occurred and the steers, which were usually fed at 0800 each day were not fed until 1200. When the steers were fed, they were only given 5-10 lb at a time about every two hours to help keep them on feed. Day 24 is the fourth day on the finishing diet (92.5% concentrate), probably one of the most critical days during the grain adaptation period. It is important to note these steers were at ad libitum levels of intake and that all had some feed left in the bunk on the morning of day 24. However, by 1200 all of the bunks were slick and the steers were somewhat aggressive. Average ruminal pH likely increased on this day because the steers were out of feed for about four hours, after which they were offered feed spread out over an extended period of time. On day 25, steers were given their feed as normal. Figure 5 shows the dramatic decrease in average ruminal pH on day 25 and thereafter. As indicated by both the very low ruminal pH and slightly reduced intakes, the steer represented by circles in Figure 5 suffered subacute acidosis for several days following the feeding mistake. It is important to note these values are average daily ruminal pH; minimum daily

ruminal pH reached below 5.0 for all three steers during this period. It is interesting to note that later in this trial period there were unsuccessful attempts to induce subacute acidosis by fluctuating dry matter intake by 4 lb per day. Feeding four hours late had a much more substantial effect on acidosis than intake variation of 4 lb per day. This suggests consistency and timing of feeding are critical management components in order to avoid acidosis.

These are just a few examples of anecdotal events and observations made with this system of continual feed intake and ruminal pH monitoring. Often these observations are as interesting and informational as the results collected from the respective trial. One important point needs to be emphasized. Acidosis affects individual cattle. Through continual monitoring of feed intake and ruminal pH of individual steers, it is evident that virtually all steers experience varying degrees of subacute acidosis sometime during feeding. It is unlikely, however, that these bouts would ever be noticed in a feedlot pen. Although a complete pen of cattle may not be "off feed", individual cattle are likely experiencing bouts of subacute acidosis. Many times, this acidosis goes unnoticed because individuals with reduced intake are "averaged out" by the other cattle in the pen not experiencing acidosis.

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Phosphorus Requirement of Finishing Yearlings

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The phosphorus requirement for finishing yearlings is 0.14 % of dietary DM or less, suggesting phosphorus supplementation in corn-based diets fed to yearlings is unnecessary.

Summary

Sixty yearling crossbred steers (849 lb) were fed individually either 0.35 or 0.70 % of DM as Ca and 0.14, 0.19, 0.24, 0.29 or 0.34 % P. Ash content was determined on bones from the lower front legs and one rib from each carcass was used to determine breaking strength. Performance and bone characteristics were not affected by dietary P concentration or P intake. Steers fed the 0.70 % Ca diets had lower gains and poorer efficiencies when compared to those fed 0.35 % Ca. These results indicate the requirement for finishing yearlings is 0.14 % P or less and it is not necessary to supplement P in typical finishing diets fed to yearling steers, as corn is usually greater than 0.25 % P.

Introduction

Manure management is a critical issue. Phosphorus can limit the amount of manure applicable to cropland as P doesn't volatilize, while 50 % or more of the N is lost as ammonia. Given P isn't volatile and doesn't leach as N, surface excesses of P can be an impor-

Table 1. Diet composition (% of diet DM).

ITEM ^a	Low P, Low Ca	High P, Low Ca	Low P, High Ca	High P, High Ca
DRC	34.5	34.5	34.5	34.5
BRAN	22.5	22.5	22.5	22.5
GRITS	22.5	22.5	22.5	22.5
COBS	7.5	7.5	7.5	7.5
Molasses	5.0	5.0	5.0	5.0
Fat	3.0	3.0	3.0	3.0
Suppl. ^b	5.0	5.0	5.0	5.0
limestone	0.75	0.75	1.67	1.67
salt	0.30	0.0	0.30	0.0
sodium phosphate	0.0	0.72	0.0	0.73
CP	12.0	12.0	12.0	12.0
Ca	0.35	0.35	0.70	0.70
P	0.14	0.34	0.14	0.34

^aDry-rolled corn, corn bran, brewers grits and ground corncobs^bSupplement contained tr.min., vit., rumensin/tylan, KCl, urea and carrier**Table 2. Animal performance as influenced by P and Ca.**

% P	P intake g/d	ADG lb/d	DMI lb/d	Feed/ gain ^c	HCW ^d lb	Fat ^e inches	QG ^f
0.14	15.9	3.87	25.0	6.49	776	0.41	17.9
0.19	19.7	3.57	22.8	6.37	755	0.40	18.7
0.24	27.6	3.77	25.2	6.71	776	0.42	18.5
0.29	32.1	3.85	24.4	6.33	774	0.43	17.9
0.34	36.4	3.38	23.6	7.04	745	0.43	18.9
SE	.74	.20	.73		21	.03	.34
% Ca							
0.35		3.88 ^a	24.4	6.29 ^a	776	0.41	18.2
0.70		3.50 ^b	24.0	6.90 ^b	755	0.43	18.5
SE		.13	.47		14	.02	.21

^{a,b}Means within a column with unlike superscripts are different (P<.05)^cAnalyzed as gain to feed, the reciprocal of feed to gain.^dHot carcass weight^eFat depth at 12th rib^fQuality grade where 18 = Select+, 19 = Choice-

tant concern if surface runoff is not completely controlled. Dietary manipulations decreasing P in the manure can alleviate some of these concerns.

Since ruminants can utilize organic (phytate) P, supplementation may not be as critical as previously thought. In addition, previous research was conducted with younger calves which were not fed high-energy rations and gained less than 1 to 1.5 lbs/d. Our objective with this study was to determine the P requirement of yearling cattle fed a high-energy diet.

Procedure

From September 4 to December 18, 1996 (105 d), 60 yearling crossbred

steers (BW = 849 lb) were individually fed once daily using Calan gates. Steers were randomly assigned using a 2 X 5 factorial design to one of 10 treatments (6 hd/trt). Treatments consisted of two levels of Ca, either 0.35 or 0.70 % of dietary DM, with limestone as the source of supplemental Ca. Within each Ca level were five levels of P, either 0.14 which contained no supplemental P, 0.19, 0.24, 0.29 or 0.34 % of dietary DM. Supplemental P was provided by mono-sodium phosphate (NaP) instead of dicalcium phosphate to allow the Ca levels to remain constant at all P levels. Two supplements (no P and high P) for each Ca level were blended at time of feeding to achieve appropriate levels of supplemental P.

Diets (Table 1) contained 34.5 % dry-rolled corn (DRC), 22.5% brewers grits, 22.5 % corn bran, 7.5 % ground corncobs, 5.0 % molasses, 3.0 % fat and 5.0 % supplement on a DM basis. Since DRC contains 0.25 to 0.30 % P, brewers grits and corn bran were fed to decrease the dietary P level to 0.14 %. Both feedstuffs are high in energy and corn products, with grits being primarily corn starch and bran consisting of the digestible corn fiber. Diets were formulated for 12.0 % protein and contained 25 g/ton Rumensin and 10 g/ton Tylan. Steers were adapted to finisher rations by limiting intake and gradually increasing DM offered until ad libitum intakes were attained. Steers were implanted on day 1 with Revalor-S. Steers were housed in covered pens with 30 hd/pen. Initial weights were the average of weights taken before feeding on three consecutive days. Final weights were calculated from hot carcass weight divided by a common dressing percentage (62). Liver abscess scores and hot carcass weights were recorded at slaughter. Quality grade, yield grade and fat thickness at the 12th rib were recorded after a 36 hour chill.

Status of P in bone is a good indicator of whether the P requirement has been met. The animal can not distinguish P and only resorb that mineral from bone. Instead, the animal must breakdown the entire complex to mobilize P. At slaughter, two bones (first phalanx) were collected from each front leg to determine total mineral content. One rib was also collected from each carcass to determine breaking strength. After collection, each bone was trimmed of soft tissue and frozen until analysis. Phalanx bones were ashed for 24 hr at 600°C to determine total mineral. The ribs were thawed and broken on an Instron Universal Testing Machine for an objective measure of bone strength.

Results

Because there were no interactions between Ca and P levels, only main effects for P (n=12) and Ca (n=30) are presented (Table 2). Dry matter intake (DMI), ADG and feed efficiency were

(Continued on next page)

Table 3. Bone characteristics with main effects of P and Ca.

% P	Phalanx		bone area (mm ²)	Ribs		
	total ash (grams)	% ash (g/100 kg HCW)		AUC ^c (mm ²)	peak ^d (lbs)	time ^e (mm)
0.14	28.29	8.01	275	505	784	19.9
0.19	27.51	8.02	262	516	741	20.8
0.24	28.86	8.20	267	504	770	20.1
0.29	27.50	7.83	269	502	759	21.3
0.34	28.52	8.46	283	477	796	18.3
SE	.98	.20	10	30	44	1.2
% Ca						
0.35	28.01	7.96	269	502	735 ^a	21.0 ^a
0.70	28.26	8.25	273	500	805 ^b	19.2 ^b
SE	.62	.13	6.5	19	26	.8

^{a,b}Means within a column with unlike superscripts are different (P<.10).

^cArea under curve, measure of peak force and time for breaking strength.

^dPeak force required to break rib.

^eTime required to break rib.

similar across P levels. Although intakes were variable due to individual feeding, no consistent trends (linear, quadratic, or cubic) were evident due to P intake. Steers fed 0.70% Ca had numerically lower DMI and gained slower (P<.05) than steers fed 0.35% Ca. Feed efficiency was also improved (P<.05) when steers were fed the lower level of Ca.

Bone density of the first phalanx bones, whether expressed as total grams of mineral or as % of carcass weight, was unaffected by P level (Table 3). Rib bone area and breaking strength, when expressed as area under curve, peak force in lbs or time before breaking, also were unaffected by P intake. Steers fed the higher percent Ca did not have greater phalanx bone density or rib bone area. Ribs from steers fed 0.70% Ca required greater (P<.10) peak force but less time to break than steers fed 0.35% Ca.

In previous studies, levels of Ca in excess of requirement have resulted in lower intakes due to limestone's palatability problems. While intakes were depressed with the higher level of Ca, gains were similar, resulting in improved efficiency. The efficiency improvement has been attributed to a buffering effect, causing less acidosis-related problems with elevated levels of Ca. In this study, the higher Ca decreased both gains and efficiency.

Since the finisher contained 22.5% corn bran, the diet contained less starch than a typical 85 % corn diet. With less starch fed, acidosis problems may be reduced and any benefits from Ca buffering would not be evident as the results suggest. Decreased gains at the high level of Ca may be attributable to less energy being used for gain, since limestone replaced DRC, and the slightly lower intake would presumably suggest less energy was available for gain once the maintenance requirement was met.

Previous studies have suggested the Ca:P ratio is insignificant for beef cattle if between 1:1 and 7:1. These results support that conclusion, since there was no interaction shown between Ca and P levels with ratios between 1:1 and 5:1. Additionally, P required for maximal gain and bone maintenance for finishing yearlings is equal to or less than 0.14 % of dietary DM or 15.9 grams/day. The 1996 NRC overestimates P required for these animals, and predicts 0.22 % of diet DM or 22.6 g/d P intake. However, high Ca levels may depress performance if limestone is used and byproducts are fed to minimize acidosis-related problems.

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