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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

[a]Dry-rolled corn, corn bran, brewers grits and ground corncobs
[b]Supplement 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)
[c]Analyzed as gain to feed, the reciprocal of feed to gain.
[d]Hot carcass weight
[e]Fat depth at 12th rib
[f]Quality 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

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

	Phalanx		Ribs			
	total ash	% ash	bone area	AUC[c]	peak[d]	time[e]
% P	(grams)	(g/100 kg HCW)	(mm^2)	(mm^2)	(lbs)	(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).
[c]Area under curve, measure of peak force and time for breaking strength.
[d]Peak force required to break rib.
[e]Time 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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