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Summary

Five ruminally fistulated steers were fed five finishing diets containing varying levels and sources of phosphorus (P). Diets consisted of 3 brewer's grits-based diets consisting of one with no supplemental P (0.12) and two supplemented with mineral P (0.27%, and 0.42% P), one corn-based diet (0.30% P), and one diet containing dry distillers grains (0.36% P). As P intake increased, P excretion increased and was positively correlated (r = 0.67; P < 0.01) to P intake. Most of the P excretion was fecal P averaging 88.7% of total excretion. With the exception of steers fed the 0.12% P diet with very little (0.50 g/day) urinary P, steers fed the other treatment diets excreted an average 2.1 g/day via the urine. These data suggest that P intake is positively correlated to P excretion and diet P concentration may impact route of excretion.

Introduction

There is a growing interest in reducing P excretion from finishing cattle. One way to lower the amount of P excreted is by reducing the amount of P fed. Previous research suggests as dietary P increases, amount of fecal P excretion increases from cattle fed roughage-based diets (Valk et. al. 2002). The effects of dietary P levels on P excretion have not been well documented in feedlot diets, therefore the objective of this study was to evaluate the effects of dietary P concentrations on amount and route P excretion when cattle are fed finishing diets.

Procedure

Five ruminally fistulated steers (initial BW = 850 lb + 87 lb) were utilized in a 5 x 5 Latin square experiment. Diets (Table 1) consisted of three brewers grits-based diets formulated for 0.12% P (LOWP) with monosodium phosphate added to increase P level to 0.27 (MEDP) and 0.42% P (HIGHP). Diets consisted of 50% coarse brewers grits, 20% dry-rolled corn (DRC), 15% corn bran, 5% grass hay, 5% molasses, and 5% supplement and were similar to those in a P requirement study previously reported (*2004 Nebraska Beef Report*, pp. 49-51). The remaining two diets were a DRC-based diet (CORN) and a dry distillers grain diet (DDGS). The CORN diet consisted of 85% DRC, 5% grass hay, 5% molasses, and 5% supplement. The DDGS diet contained 57% DRC, 30% dry distillers grains, 5% grass hay, 5% molasses, and 3% supplement. Diets contained 0.12%, 0.27%, 0.42%, 0.30% and 0.36% P (DM basis) for

(Continued on next page)

Table 1. Diet composition for finishing rations (% DM basis).

Ingredient	Treatments				
	LOWP[a]	MEDP[a]	HIGHP[a]	CORN[b]	DDGS[c]
Brewers Grits	50	50	50	—	—
DRC[d]	20	20	20	85	57
DDGS[e]	—	—	—	—	30
Corn Bran	15	15	15	—	—
Grass Hay	5	5	5	5	5
Molasses	5	5	5	5	5
Supplement	5	5	5	5	3

[a]Monosodium phosphate replaced fine ground corn in the supplement. Diets contained 0.12%, 0.27% and 0.42% P for LOWP, MEDP, and HIGHP, respectively.
[b]CORN contained 0.30% P.
[c]DRC replaced fine ground corn in the supplement. Diet contained 0.36% P.
[d]DRC means dry rolled corn.
[e]DDGS means dry distillers grains.

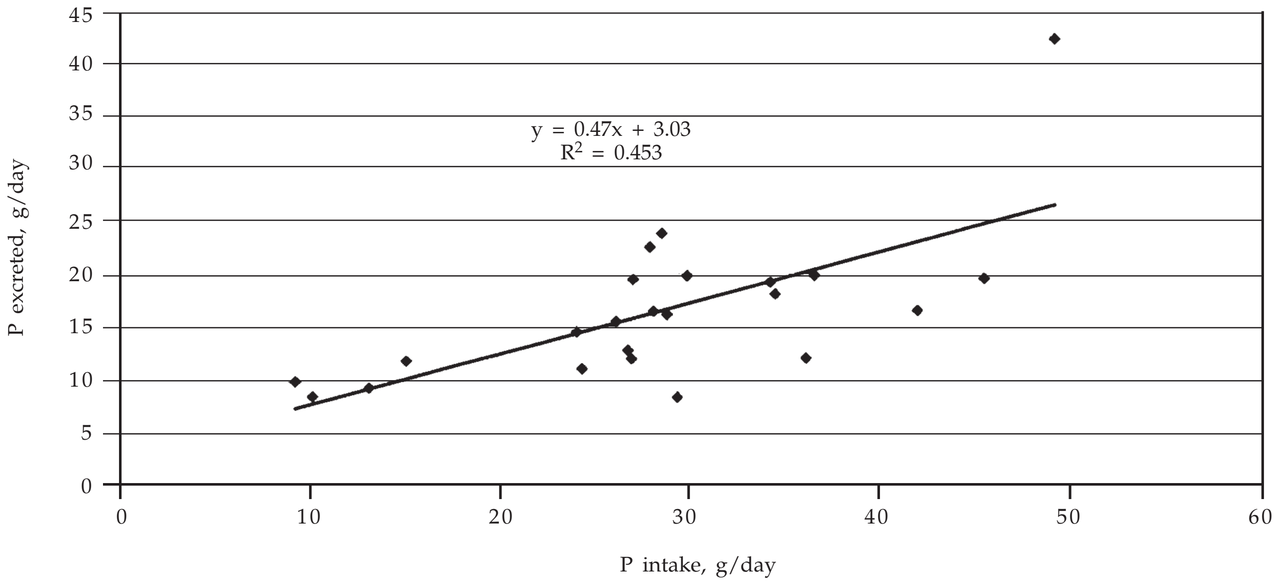

Figure 1. Relationship between P intake and P excretion for steers fed varying concentrations of dietary P.

Table 2. Intake and excretion of P from steers consuming different levels of dietary phosphorus.

	Treatments[a]					Statistics	
Item	LOWP	MEDP	HIGHP	CORN	DDGS	SEM	F-Test
Diet P, %	0.12	0.27	0.42	0.30	0.36		
DMI, lb/day	20.7	23.2	21.5	21.1	20.9	1.5	0.16
P Intake, g/day	10.5 [d]	26.7 [e]	37.9 [h]	29.5 [f]	34.6 [g]	0.7	<0.01
P Excreted, g/day	9.5 [d]	16.3 [de]	25.0 [f]	14.2 [de]	18.0 [ef]	2.9	0.04
Urine P, g/day	0.50 [d]	2.18 [e]	1.78 [e]	2.17 [e]	2.26 [e]	0.52	0.03
Fecal P, g/day	9.2 [d]	14.2 [de]	23.2 [f]	12.1 [de]	15.8 [ef]	3.1	0.07
% Urine [b]	4.1	14.2	9.5	16.7	12.3	3.5	0.22
% Feces [b]	95.9	85.8	90.5	83.4	87.7	3.5	0.22
% of Intake [c]	85.2[a]	60.9[b]	65.5[bc]	47.8[bd]	54.2[bcd]	7.6	0.04

[a]Treatments include three brewers grits diets with varying levels of supplemental mineral P (LOWP, MEDP, and HIGHP), a corn-based diet (CORN), and a distillers by-product diet (DDGS).
[b]Phosphorus excreted in either urine or feces as a percentage of total phosphorus excreted.
[c]Percentage of phosphorus excreted as a percentage of phosphorus intake.
[d,e,f,g,h]Means within a row with different superscripts are different ($P < 0.10$).

Table 3. Diet digestibility of finishing diets with different levels of P.

	Treatments[a]					Statistics	
Item	LOWP	MEDP	HIGHP	CORN	DDGS	SEM	F-Test
DMD, %[b]	75.4	69.8	74.4	64.9	75.3	2.7	0.07
OMD, % [c]	76.4	71.6	75.6	65.8	76.7	2.7	0.07
PD, % [d]	11.1[e]	39.1[f]	33.3 [f]	52.2 [f]	45.8 [f]	7.5	0.04

[a]Treatments include three brewers grits diets with varying levels of supplemental mineral P (LOWP, MEDP, and HIGHP), a corn-based diet (CORN), and a distillers by-product diet (DDGS).
[b]Dry matter digestibility.
[c]Organic matter digestibility.
[d]Phosphorus digestibility
[e,f]Means within a row with different superscripts differ ($P < 0.05$).

LOWP, MEDP, HIGHP, CORN and DDGS, respectively. In the MEDP and HIGHP diets the P source was inorganic phosphate which was supplied with the substitution of monosodium phosphate for fine ground corn as part of the supplement. The source of P in the LOWP, CORN, and DDGS diets was organic in the form of phytate. Steers were fed ad libitum once daily at 0700 and were allowed to adapt to diets for 16 days followed by a 5-day collection period. Chromic oxide was dosed (10g/day) directly into the rumen using gel capsules, twice daily (0600 and 1700) for the final eight days of every collection period.

A funnel system was used to collect total urine for the final five days of the collection period. Urine collection containers were drained three times daily (0600, 1200, and 1700 hours), urine volume was recorded and a 45 ml sub-sample was taken. Urine samples were frozen and later analyzed for urine P concentration using a commercial kit (Diagnostic Chemicals Limited).

Fecal samples were collected three times daily (0600, 1200, and 1700 hours) and dried in a 60°C forced air oven. They were composited by collection period and ground through a 1 mm screen using a Wiley mill. They were stored and later analyzed for chromium, nitrogen, and P concentration. Diet and ingredient samples were taken daily during the last eight days of the collection period and composited by collection period for analysis. Composite samples were dried using a 60°C forced air oven and ground, then analyzed for P concentration.

Results

Dry matter intake and phosphorus excretion data are shown in Table 2. There were no significant treatment differences in DMI ($P > 0.10$). Average intake for all treatments was 21.5 lb/day. The P intakes were 10.5, 26.7, 37.9, 29.5 and 34.6 g/day for LOWP, MEDP, HIGHP, CORN, and DDGS diets, respectively.

Route of excretion did appear to be related to P intake. Steers fed the LOWP excreted very little urinary P and less ($P < 0.01$) than all other treatments. However, urinary P excretion was variable, but similar on the other treatments. Based on previous research, only small amounts of P are excreted in the urine; however, an average of 2.1 g/day was excreted by steers on all other treatments except LOWP. Fecal excretion of P was significantly different ($P = 0.07$) among treatments. Therefore, total P excretion (fecal and urinary P combined) was different ($P = 0.04$) across treatments.

Figure 1 depicts the relationship between P intake and P excretion. As expected, when more P is fed, more is excreted. P intake and P excretion were significantly and positively correlated (r = 0.67). From Figure 1, the intercept (3.1 g/day) depicts the predicted maintenance requirement or the P excreted when no P is consumed by cattle. Comparing this calculated maintenance requirement to 1996 NRC equations for 850 lb steers, the estimated maintenance requirement is greater (6.2 g/day) than calculated values in this study. One point, however, is quite high with an animal consuming 50 g/day of P and excreting 42 g/day. If that data point is removed, the calculated maintenance requirement is 7.5 g/day; however, the relationship is not as strong with this animal removed.

Digestibility data are shown in Table 3. There were no differences ($P > 0.10$) in either organic matter digestibility (OMD) or dry matter digestibility (DMD). Phosphorus digestibility was influenced by diet with the lowest digestibility with steers fed LOWP. The remaining treatments were not different and averaged 42.6% P digestibility. Surprisingly, P digestibility was not depressed at higher P intakes.

As the P concentration of the diet increased, so did the amount of P that was excreted. Most of the P excreted is in the feces whereas little P is excreted in the urine. Reducing the dietary P in feedlot rations by eliminating supplemental P can reduce the amount of P excreted. This will increase the N:P ratio and reduce the amount of P entering fields. Eliminating P supplementation is supported by previous research (*2004 Nebraska Beef Report*, pp. 49-51; *2002 Nebraska Beef Report,* pp. 45-48) which has shown that feeding levels as low as 0.17% P (DM basis) to calf-fed heifers and steers has no adverse effects on cattle performance. Feeding P levels as low as 0.14% P to yearling steers (*1996 Nebraska Beef Report*, pp. 78-80) did not affect performance. Eliminating supplemental P from corn or corn/by-product diets will reduce the amount of P excreted while maintaining cattle performance. It is still unclear how amount or route of excretion may influence solubility of P. Recent research in dairy cattle suggests that soluble P may be increased as dietary P (and P excretion) is increased. Presumably, the greater the solubility of P, the greater the potential for manure P challenges in runoff. This experiment will be analyzed in the future to assess solubility of P with these different diets.

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