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Abstract

We used 117 crossbred pigs and 260 male White Leghorn chicks to determine the availability of phosphorus in high-moisture sorghum grain treated with propionic acid or stored in an oxygen limiting structure, and in field-dried sorghum grain. Bone breaking force as the criterion in the pig studies and tibia bone ash as the criterion in the chick studies gave availability estimates of 19, 42, and 43% for the pig and 25, 46, and 48% for the chick for dry, HMPA and HMO2L, respectively.; Swine Day, Manhattan, KS, November 8, 1979

Keywords

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Phosphorus Availability in Dry and High-moisture Sorghum Grain for Growing Swine and Chicks

Mike Trotter and Gary Allee

Summary

We used 117 crossbred pigs and 260 male White Leghorn chicks to determine the availability of phosphorus in high-moisture sorghum grain treated with propionic acid or stored in an oxygen limiting structure, and in field-dried sorghum grain. Bone breaking force as the criterion in the pig studies and tibia bone ash as the criterion in the chick studies gave availability estimates of 19, 42, and 43% for the pig and 25, 46, and 48% for the chick for dry, HMPA and HMO_2L, respectively.

Introduction

Most of the plant source phosphorus is in various organic compounds found primarily in the seed, and phytate phosphorus, whose availability is questionable, is the predominant organic form. Attempts to increase the availability of phytate phosphorus by various feed processing methods have given varied results. Some researchers have shown a positive effect from steam processing while others have shown no effect. The most marked changes have been observed between high-moisture and dry corn.

We compared high-moisture sorghum grain treated with propionic acid or stored in an oxygen limiting structure and field-dried sorghum grain for growing pigs and chicks and determined availability estimates for phosphorus for each grain type.

Procedures

Grain diets were ground, mixed, and incorporated on an equal dry matter basis. The three grain types used were field-dried (dry) sorghum grain (13% moisture), high-moisture sorghum grain treated with propionic acid (HMPA) (23% moisture, 1.0% propionic acid), and high-moisture sorghum grain stored in an oxygen limiting structure (HMO_2L) (23% moisture). The HMO_2L sorghum grain was treated with 0.4% propionic acid before mixing to prevent spoilage. Standard curves were established by feeding graded levels of monosodium phosphate (NaH_2PO_4). Grain was added to the diet at the expense of dextrose. Grain levels used were 21% of the ration (0.065% grain P), 42% (0.130% grain P), and 63% (0.195% grain P) in the pig studies and 16% (0.05% grain P), 32% (0.10% grain P), and 48% (0.15% grain P) in the chick studies.

In the pig studies, 117 crossbred weanling pigs averaging 11.56 kg (25.4 lb) were randomly allotted to 13 treatment groups. They were group fed and housed in an environmentally controlled ($75^{o}F$) nursery. Pigs had free access to both feed and water throughout the experiment. At the end of the 35-day feeding trial, five pigs from each treatment group were slaughtered and their right front legs were removed for bone analyses.

In the chick studies, day-old male White Leghorn chicks were wing-banded and placed in electrically heated, brooder battery cage tiers with wire floors. They were supplied with water and a standard 20% protein diet ad libitum. On day 9 post-hatching, chicks were weighed and randomly allotted into 26 lots of 10 chicks each, representing two lots each of 13 treatment groups. At the end of the 12-day feeding trial, 10 chicks from each treatment group were slaughtered by cervical dislocation and their right tibias were removed for analyses.

Results and Discussion

The bone data for both pigs (table 27) and chicks (table 28) showed similar trends. All criteria responded linearly ($P<.05$) to phosphorus supplementation, whether phosphorus additions were from NaH_2PO_4 or from sorghum grain. Comparing grain treatments by analysis of variance showed that both pigs and chicks receiving either of the high-moisture treatments had increased bone development, measured as bone breaking force and dry, fat-free bone weight, ash, calcium and phosphorus, compared to animals receiving dry grain.

To determine phosphorus availability estimates from grain, the slope of the grain response curves were divided by the slope of the inorganic phosphorus response curves (figures 2 and 3). The basal diet was used in each grain response curve to represent zero grain phosphorus intake. Phosphorus availability estimates which were very similar for both species were: 19, 42, and 43% for the pigs, and 25, 46, and 48% for the chick for dry, HMPA, and HMO_2L sorghum grain, respectively.

Table 27. Effects on Bone Development of Feeding Graded Levels of Inorganic or Sorghum Grain Phosphorus to Growing Swine[a]

Treatment	Breaking force[b] (kg)	Bone weight[c] (g)	Bone ash[c] (g)	Bone calcium[c] (g)	Bone phosphorus[c] (g)
Basal	25.0	5.02	3.00	1.07	0.48
B + .1% P	43.0	6.90	3.85	1.47	0.69
B + .2% P	59.8	8.52	4.64	2.00	0.92
B + .3% P	81.3	10.27	5.70	2.39	1.17
Dry .065	26.8	5.22	3.10	1.11	0.50
Dry .130	28.9	5.43	3.22	1.16	0.53
Dry .195	30.7	5.64	3.33	1.22	0.56
HMPA .065	29.1	5.42	3.29	1.18	0.53
HMPA .130	33.8	5.85	3.46	1.28	0.59
HMPA .195	38.0	6.26	3.68	1.38	0.65
HMO_2L .065	29.2	5.42	3.22	1.17	0.53
HMO_2L .130	34.0	5.85	3.46	1.28	0.59
HMO_2L .195	38.1	6.26	3.68	1.37	0.65

[a]Each value is the mean of 5 pigs per treatment.

[b]Breaking strength values obtained on right ulna.

[c]Bone weight, ash, Ca and P values from right radius and reported on dry, fat-free basis.

Table 28. Effects on Bone Development of Feeding Graded Levels Inorganic or Sorghum Grain Phosphorus to Young Chicks[a]

Treatment	Phosphorus intake/day[b] (mg)	Bone weight[c] (mg)	Bone ash[c] (mg)	Bone phosphorus[c] (mg)	Bone calcium[c] (mg)
Basal	20.56	284.55	155.38	29.67	53.01
B + 0.1% P	42.59	298.37	166.96	32.36	58.98
B + 0.2% P	62.15	318.89	181.02	35.08	64.72
B + 0.3% P	89.72	338.56	193.61	38.88	70.14
Dry 0.05% P	10.38	286.21	156.34	29.90	53.51
Dry 0.10% P	21.66	287.98	158.08	30.03	53.92
Dry 0.15% P	32.39	289.73	159.90	30.40	54.69
HMPA 0.05% P	11.13	287.42	157.32	30.24	55.12
HMPA 0.10% P	22.00	290.31	160.00	30.72	56.21
HMPA 0.15% P	30.52	292.86	163.38	31.19	57.14
HMO_2L 0.05% P	11.16	287.39	157.80	30.35	54.50
HMO_2L 0.10% P	21.66	290.24	160.28	30.78	55.22
HMO_2L 0.15% P	30.06	293.02	163.66	31.32	56.28

[a]Each value is the average of 10 chicks per treatment.

[b]Phosphorus intake on standard curve diets - inorganic phosphorus from NaH_2PO_4. For grain diets - grain source phosphorus.

[c]Bone weight, ash, Ca, and P values from right tibia and reported on dry, fat-free basis.

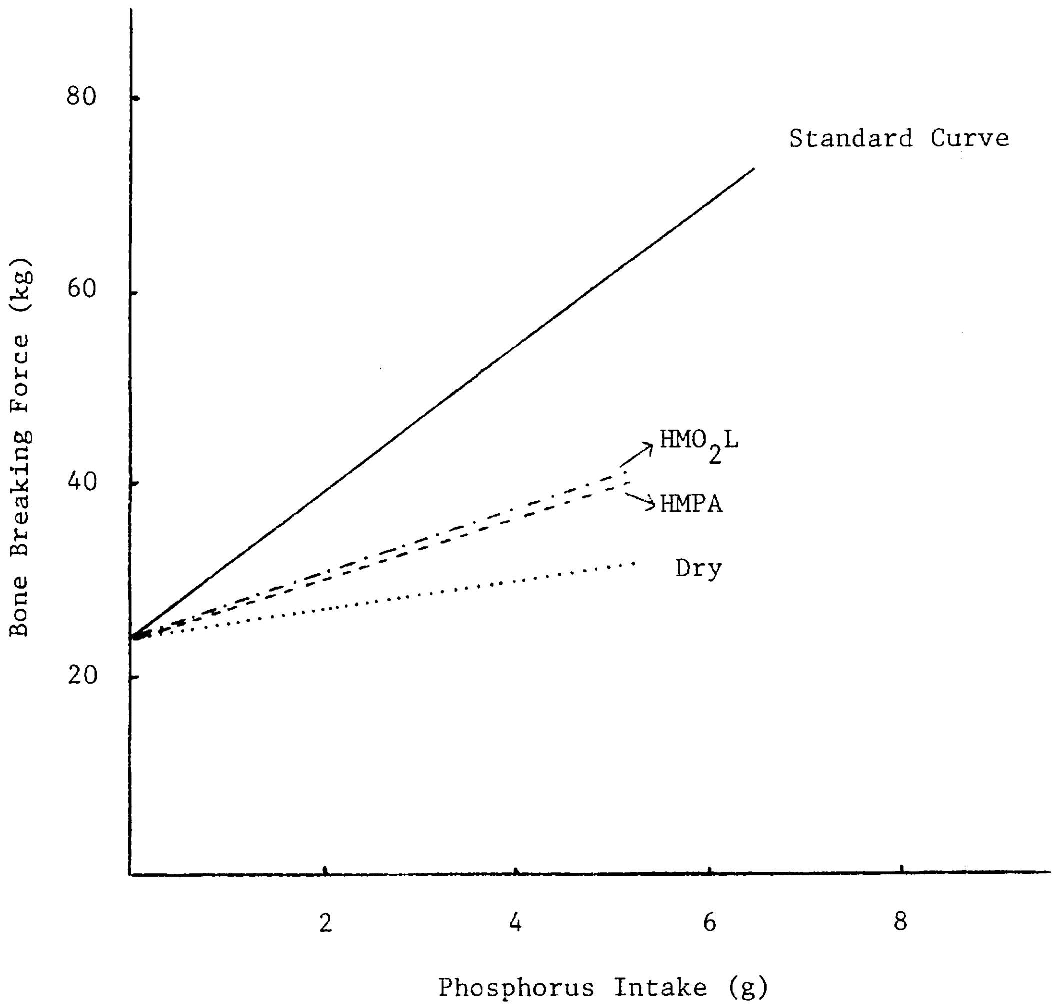

Figure 2. Phosphorus response curve for pigs

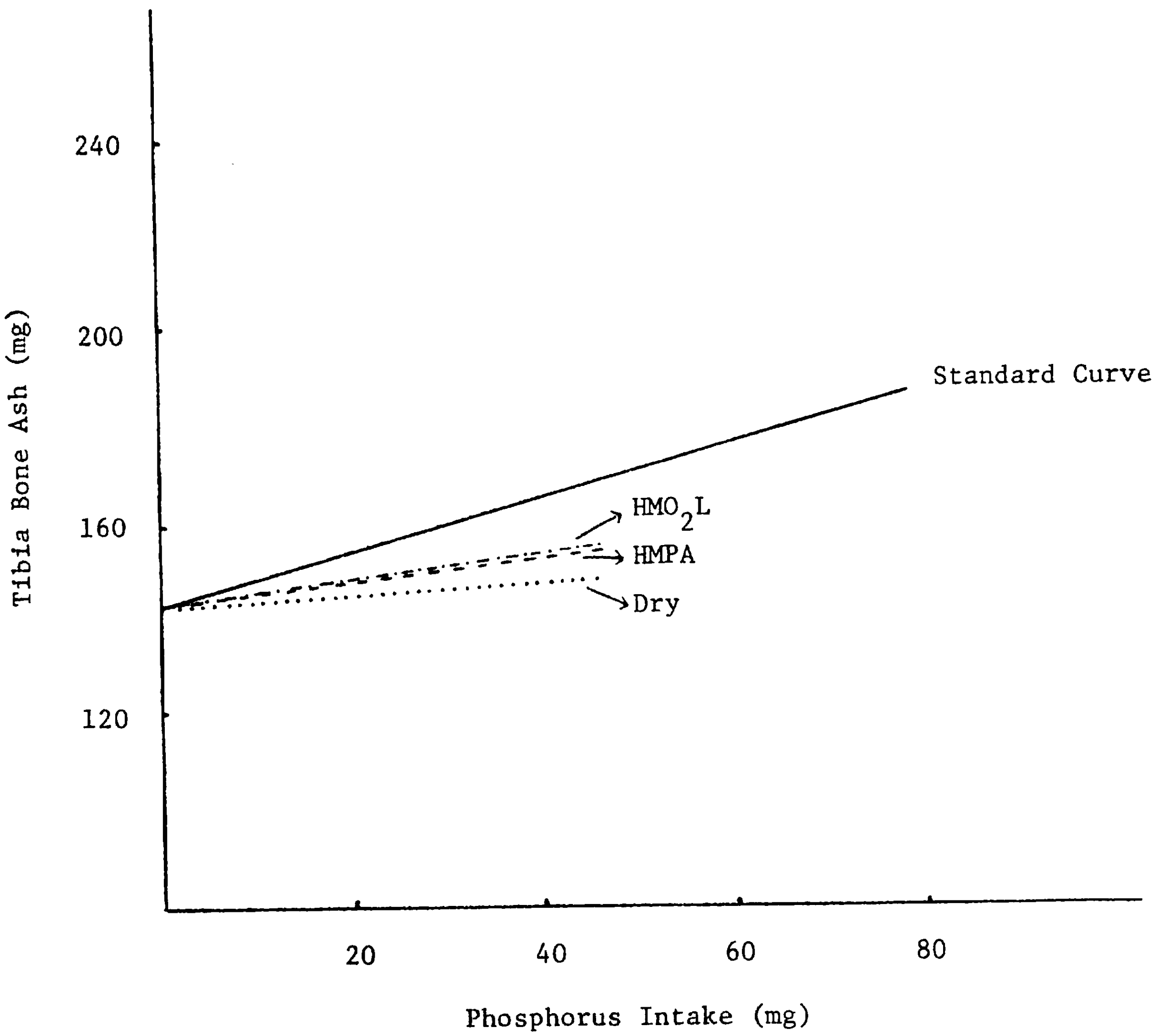

Figure 3. Phosphorus response curve for chicks