# THE BIOAVAILABLE PHOSPHORUS CONTENT OF SOME COMMON NORTH DAKOTA FEEDSTUFFS

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North Dakota swine and poultry producers must have concern for the availability of phosphorus in feedstuffs. the major portion of the phosphorus in plant seeds is in the form of phytic acid, a form that is of limited availability to nonruminant animals.

Chicks and pigs respond similarly to phosphorus supplementation. Cost-efficient information was obtained by utilizing an established chick bioassay that was modified to further reduce costs while permitting rapid evaluation of the biologically available phosphorus content of several feedstuffs commonly available in North Dakota.

An overview of several experiments is presented in this report.

Phosphorus is an expensive nutrient that must be added to swine and poultry diets. Phosphorus deficiency symptoms include reduced rate and efficiency of growth and soft, easily fractured bones. Swine and poultry producers naturally wish to limit the amount of added phosphorus to the minimum necessary to meet the requirements of the animals because of the cost of phosphorus. This problem is compounded by the potential for variation in the availability of phosphorus among feedstuffs.

The experiments summarized in this report were conducted to provide North Dakota swine and poultry producers with information concerning the available phosphorus content of several common feedstuffs.

## METHOD

Chicks and pigs are nonruminant animals and have many nutritional similarities. One of these is the inability to utilize plant phosphorus. This similarity was utilized to an advantage in reducing the cost of obtaining this information.

Chicks are started on experiment at an age of eight days. Nonspecific death losses have passed and unthrifty chicks may be avoided at this age. The chicks selected for use in the experiment are fed test diets for a short period of time (seven to 11 days), at which time the chicks are sacrificed and the right tibias are collected for analysis. The gain in ash content of the right tibia is related to the amount of phosphorus consumed by a procedure known as the "slope ratio method".

## RESULTS

The results of the various experiments are summarized in Table 1. Two samples of barley were evaluated in separate experiments. These samples proved to differ in percent total phosphorus as well as in percent of phosphorus which was biologically available to the chick. Curiously, the percent available phosphorus in each sample of ground barley was comparable.

The oat sample tested had a low phosphorus content (.31 percent) but much of that phosphorus (47 percent) was available to the chick. The available phosphorus content of the oat sample was slightly greater than either sample of barley.

Corn and soybean meal are the major sources of energy and protein in feed for swine and poultry in the United States. Unfortunately, neither corn nor soybean meal are good sources of available phosphorus. Ground barley and ground oats, for example, contained nearly twice the available phosphorus present in corn or soybean meal.

Feeds for nonruminants may be in meal (ground) or pelleted form. It has been suggested that pelleting might improve the availability of phosphorus by certain chemical changes that might occur during the addition of steam and during the pelleting process itself. This concept was not supported by the results of these experiments. In some instances, the availability of phosphorus appeared to be reduced by the pelleting process. This important facet requires more extensive study.

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Wheat is not a common feedstuff for swine or poultry simply because of price relationships. Wheat is more valuable as a human **foodstuff** than as an animal **feedstuff.** The one wheat sample examined had a very low phosphorus availability in this study. This low phosphorus availability for hard red spring wheat (HRSW) appears valid in view of the slightly higher value for sprouted HRSW. Sprouting activates an enzyme that releases bound phosphorus. A third value, that of HRSW screenings, also appears realistic. If it is assumed that the screenings were approximately half wheat and half weed seeds, the 19 percent phosphorus availability could represent the average of a low value for wheat and an "intermediate" value for the weed seeds. It might appear that the phosphorus availability of weed seeds is comparable to that of barley or oats. It will be especially useful to turkey producers, who utilize large amounts of screenings in their operations, should additional experimentation confirm this assumption.

The value for dicalcium phosphate sample tested in one experiment deserves explanation. The generally accepted value for phosphorus availability from dicalcium phosphate is 90 percent. However, we had some subtle indications from feeding trials (designed to answer other questions) that the value might be less for this particular sample. Reduced availability proved to be the case for this particular sample. Reduced availability of phosphorus in dicalcium phosphate may occur if the product is dried at an excessive temperature.

Sunflower meal may be a valuable source of supplemental protein under certain economic conditions. Two types of sunflower meal, 42 percent crude protein and 28 percent crude protein, were evaluated in the most recent experiment of this series. Interestingly, the phosphorus availability values of the two types of sunflower meal were nearly identical. The percent available phosphorus values for the two types of sunflower meal are of more interest. These values indicate that sunflower meal may contain up to three times the available phosphorus that may be present in soybean meal. This characteristic may be especially valuable to North Dakota swine or poultry producers who elect to use the higher protein sunflower meal in rations for their animals or birds. (The 28 percent protein sunflower meal is high in fiber and therefore lower in energy and may not be used in the majority of swine and poultry rations.)

### Using These Values in Swine Rations

Current swine nutrient requirements are based upon corn-soy rations, and values for total phosphorus, but not available phosphorus, are listed. It is possible to back-calculate to obtain the **estimated** available phosphorus requirement with the information currently available. This procedure will be illustrated in the following sections.

The growing pig (45 to 75 pounds) has a listed requirement of phosphorus of .5 percent and of protein for 16 percent (Nutrient Requirements of Swine, 8th edition, 1979; National Research Council — National Academy of Sciences). Nutrient requirements for swine are assumed to be based on corn-soy diets. If we calculate the proportions of corn and soybean meal needed to satisfy the protein requirement, we can then calculate the phosphorus provided by the corn-soybean meal and the amount of phosphorus that must be provided for dicalcium phosphate. Finally, we may estimate the availability of the phosphorus in each of the three phosphorus-containing feedstuffs and obtain the **calculated** available phosphorus requirement. For the growing pig (45 to 75 pounds) these calculations are:

| Ingredient | Percent of of Diet | Percent Phosphorus | Available Availability | Percent Phosphorus |
|---|---|---|---|---|
| Corn | 76 | .22 | 20 | .0456 |
| Soybean meal | 21 | .137 | 10 | .0137 |
| Dicalcium phosphate | 0.75 | .135 | 90 | .1215 |
| | | | | .1808 |

Note that the ration total does not equal 100 percent, as 2.25 percent of the ration space remains for the inclusion of salt, limestone, and a vitamin premix. We also have used the commonly assumed availability value of 90 percent for the phosphorus in dicalcium phosphate.

Barley is the most common cereal grain in swine rations and will be used in this example.

| Ingredient | Percent of Diet | Percent Phosphorus | Percent Phosphorus Availability | Phosphorus | Percent Available |
|---|---|---|---|---|---|
| Barley | 86 | .36 | .3096 | .36 | .111 |
| Soy | 11 | .65 | .0715 | .10 | .007 |
| | | | | | .118 |

.18-.118 = .062; .062 ÷ .162 = .38% dicalcium phosphate

These calculations indicate that approximately one-half of the dicalcium phosphate needced in corn-soy rations is required in barley-soy rations to provide comparable levels of available phosphorus. Dicalcium phosphate currently sells for $280 per ton. The 7.4 pounds of dicalcium phosphate "saved" by the higher phosphorus availability of barley (relative to corn) also may be expressed as saving $1 per ton of complete ration. This dollar per ton acquires more significance when we recognize that the developing swine industry in North Dakota utilizes in excess of 200,000 tons of feed per year!

The **calculated** available phosphorus requirements of swine are summarized below.

| Class of Swine | Calculated Available Phosphorus Requirement % |
|---|---|
| Starting pigs (25-45 lb) | .21 |
| Growing pigs (45-75 lb) | .18 |
| (75-135 lb) | .16 |
| Finishing pigs (135-220 lb) | .12 |
| Bred sows and gilts | .30 |
| Lactating sows and gilts | .21 |

These values are minimums. In many instances, it will be prudent to multiply these minimum values by 1.20 or add .05 percent available phosphorus, whichever is greater. Used constructively, these calculated available phosphorus "requirements" may be combined with the available phosphorus informtaion for individual feedstuffs to save dollars for North Dakota swine producers. The constructive combination of this information will aid in the economical producion of animals having desirable rates and efficiencies of gain as well as strong bones.

### Using These Values in Turkey Rations

Turkey producers frequently operate on a margin of a few cents per bird, so an optimum combination of minimum cost and bird performance must be achieved. Turkey producers are correctly hesitant to feed suboptimum levels of phosphorus because they are aware that a lame bird will be reluctant to move to the feeder and therefore will gain weight more slowly and less efficiently than a structurally sound bird. (A lame bird is also more susceptible to cannibalism.)

The following calculated values for estimated available phosphorus requirements of turkeys must be recognized as estimates. Turkey rations are frequently based upon a more complex misture of ingredients than will be found in many swine rations. Therefore, a modest margin of safety has been incorporated into the following estimates.

| Age of Bird | Estimated Available Phosphorus Requirement % |
|---|---|
| 0-4 weeks | .40 |
| 4-8 | .37 |
| 8-12 | .34 |
| 12-16 | .32 |
| 16-20 | .30 |
| 20 + | .28 |

The value of these estimates to turkey producers will be influenced by the ingredients that they may utilize. Large amounts of wheat screenings are commonly used in turkey rations. It could well be that the information concerning phosphorus availability from screenings will be the single item of greatest value to turkey producers.

## SUMMARY

The results of a series of experiments concerned with the available phosphorus content of a variety of feedstuffs have been centered upon their use in swine and turkey rations. (The availability of plant phosphorus to ruminants cannot be estimated from the data presente din this report.) These values may be of considerable value to North Dakota swine and poultry producers evne at low rates of implementation.

| Feedstuff | Percent Phosphorus | Availability | Percent Available Phosphorus |
|---|---|---|---|
| Barley | | | |
| Sample 1 | .29 | .43 | .12 |
| Sample 2 (ground) | .38 | .28 | .11 |
| (pelleted) | .38 | .25 | .10 |
| Oats (ground) | .31 | .47 | .15 |
| (pelleted) | .31 | .23 | .07 |
| Corn (ground) | .30 | .22 | .07 |
| (pelleted) | .30 | .04 | .01 |
| Soybean meal | .63 | .11 | .07 |
| (pelleted) | .63 | .10 | .06 |
| Wheat, HRSW | .43 | .06 | .03 |
| Field-sprouted HRSW | .41 | .16 | .07 |
| HRSW screenings | .37 | .19 | .07 |
| Dicalcium phosphate | 18.99 | .57 | 10.82 |
| Meat and bone meal | 11.06 | .69 | 7.63 |
| Sunflower meal (42% CP) | .96 | .22 | .21 |
| (28% CP) | .89 | .23 | .21 |

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ciencies possible through better management on farms of all sizes.

The upward pressure on farm size is likely to continue as the better managers seek to improve their income positions through lower unit costs and larger gross incomes associated with increasing size. The greatest improvement in farm income, as well as in overall production efficiency, would occur from public policies designed to help smaller size farms enlarge rather than from further growth of large farms.

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