PHOSPHORUS UTILIZATION AND AVAILABILITY IT'S AFFECT ON PRODUCTION AND REPRODUCTION

by

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Macro-mineral nutrition has not been a 'HOT' topic since back in the 50's and 60's when ruminant nutrition itself was developing as a science. At this time it was well documented that phosphorus deficiencies existed in many parts of the world. All of us have seen pictures of cattle suffering from extreme phosphorus deficiency, where they appear stunted, thin, unhealthy and emaciated. Except for parts of the undeveloped world, such as tribal Africa, cattle cannot be found today showing 'typical' phosphorus deficiency.

During the 60's phosphorus research was concentrated on bone formation where some 80% of the total quantity of phosphorus is found. More recently research has concentrated on the remaining 20% which is distributed throughout the body in every cell and is involved in almost every metabolic reaction. The list of essential functions of phosphorus is very impressive (Table 1).

Table 1. Essential Functions of Phosphorus

1. Bone and teeth formation and maintenance.
2. Milk production
3. Protein accretion and muscle metabolism.
4. Rumen microflora metabolism and health.
5. Efficient feed utilization.
6. Component of nucleic acids which are important in genetic transmission and control of cellular metabolism.
7. Component of buffer systems in blood and other body fluids.
8. Energy metabolism - phosphorylation of glucose.
9. Fatty acid transport system - phospholipids.
10. Component of many enzyme systems.

It is this 20% that is used for metabolism that is of major economic importance to livestock producers. A deficiency of phosphorus, therefore, does not show as a gross skeletal deformity, but shows up as less milk in the pail, a slightly lower daily gain, a little more feed per unit of production, a week longer in the feed yard or a slightly lowered resistance to disease. All of these translate to an inefficiency that increases the cost of production.

This is why it is more critical today than ever that managers evaluate the whole production system, including all of the nutritional components to determine the total economic impact. An illustration used by nutritionist shows a wooden staved water barrel where each stave represents a nutritional component such as energy, vitamin A, phosphorus, protein, etc.. One stave is slightly shorter and that stave or nutrient then becomes the most limiting and restricts performance to that limit. Likewise, the staves could represent components of the production system such as housing, feeding management, dry cow management, breeding management, husbandry, etc.. And the same principle applies.

Although this paper only addresses phosphorus, we are fully aware that all areas of nutrition and management are of concern. We do know that phosphorus can easily become a limiting nutrient in a ruminant diet. The 1989 NRC Nutrient Requirements of Dairy Cattle states, "Phosphorus deficiency affects many phases of animal performance, and deficiency effects can occur rather quickly when a cow is being fed a diet that lacks sufficient phosphorus."

The dairy cow is an excellent model to illustrate the economic importance of phosphorus in production. At any one moment in time, the blood plasma of a 1300 pound cow contains approximately 1.1 gram of total phosphorus. There is about 1 gram of phosphorus in 1 kilogram of milk: consequently, phosphorus input must be continuous to meet the needs of the cow for high milk production.

The complexity and efficiency of the biological system is apparent when we determine that a cow producing 70 pounds of milk each day has to metabolize 32 grams of phosphorus through her system. That translates to a turn over rate of the entire blood plasma of one and one-third times each hour. This dramatically emphasizes the importance of phosphorus intake on a frequent basis. One starts to appreciate the importance of proper mixing and feeding on a regular schedule when we examine the frequency of deposition of phosphorus into the mammary gland. The bottom line is that you cannot produce milk without phosphorus.

The role of phosphorus in reproduction is not as clearly defined as it is for production. We do not have a clear cut illustration such as we have with milk production. To gain a better appreciation of the role of phosphorus and overall nutrition, let's take a look at the physiological stresses at work at breeding time.

In order to gain a full appreciation regarding this stress we must back up to calving. Calving is the beginning of a series of stressful events that cause an effect on the physiological and metabolic processes at work in the cow. At or actually before the birth of a calf, the hormone system makes a drastic change from the support of the fetus to provide nourishment for the newborn. This system undergoes varying degrees of stress

depending on the ease or difficulty of the birth, the rate of recovery after birth, the health and nursing activity level of the calf, etc.. And, then especially with a dairy cow we want her to produce 4000 to 5000 pounds of milk before breeding.

We have not even touched on the environmental stresses that can occur during this sixty to ninety day period. Any one or combination of these factors may cause the cow to go off feed and/or reduce her feed consumption during this period. Earlier we reviewed the role of phosphorus in cellular metabolism which includes protein accretion as well as energy metabolism. Thus, although we cannot clearly identify the role of phosphorus in reproduction we do know that a lack of phosphorus may impair reproductive performance. Again, the concern is with the overall nutritional status of an animal and recognition of the importance of the role of phosphorus in maintaining the proper nutritional level.

Recommended Phosphorus Levels and Sources

Several resources, including NRC, are available as references for recommended nutrient levels. Table 2 is an excerpt from a reference published annually by Pitman-Moore. These levels are developed by surveying industry nutritionist, and evaluation of other published resources. As many other references indicate, these values are given as guidelines and, therefore, evaluation of the total system as mentioned in the introduction is required.

Phosphorus is found in almost every feed ingredient. Grains have a considerable amount of phytate phosphorus which is utilized to some extent by the ruminant due to the phytase enzyme produced by rumen microorganisms. The degree to which phytin phosphorus is utilized is an area of needed research. Recent work by Cromwell indicates not only a variable quantity of phosphorus in many ingredients but also a variable degree of utilization by pigs. Although ruminants will utilize much more phytate phosphorus than monogastrics, the variability remains the same.

Inorganic phosphates are the most reliable forms of supplemental phosphorus. The most commonly used sources for ruminants are monoammonium, monocalcium, and dicalcium phosphates. Sources from foreign producers require caution before using, as the production processes can be quite different than in the United States.

Summary

Phosphorus is a nutrient that requires critical consideration and evaluation by nutritionist. Lack of phosphorus in a ruminant diet will impact productive and reproductive performance which translates to an economic loss. All ruminant rations require fortification with inorganic phosphates to meet the animals requirement.

Table 2. Recommended Calcium and Phosphorus Levels for Feeds 1991. Pitman-Moore

Dairy Cattle	Ca %	P %
Calf Milk Replacer	0.7	0.5
Calf Starter	0.6	0.5
Calf Grower	0.5	0.4
Dry Cow Feed	0.5	0.4
Complete Dairy Feed	0.7	0.5
16% Dairy Feed	0.8	0.6
18% Dairy Feed	1.0	.75
20% Dairy Feed	1.2	.85
32% Dairy Supplement	3.0	1.50
36% Dairy Supplement	3.2	1.60
40% Dairy Supplement	3.5	1.70
44% Dairy Supplement	3.8	1.80
Bull Feed	0.4	0.3

Beef Cattle	Ca %	P %
Calf Creep Feed	0.8	0.6
Receiving Diet	0.6	0.4
Beef Grower	0.6	0.4
Beef Finisher	0.6	0.35
Gestation Feed	0.35	0.3
Lactation Feed	0.4	0.3
Bull Feed	0.4	0.3
20% Range Cube	2.0	1.0
32% Beef Supplement	1.5	1.0
45% Beef Supplement	2.5	1.5