

Phosphorus Is Important for Optimum Milk Production and Reproduction in Dairy Cattle



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Phosphorus is the second most abundant mineral element in the body with 80 to 85% of phosphorus in the body being found in the teeth and bones. Essentially, phosphorus is involved in every metabolic reaction and energy transfer within the body. It is required for normal milk production, growth, and efficient use of feed and by the rumen microorganisms in the digestion of cellulose and synthesis of microbial protein.

In cattle, the majority of phosphorus is excreted through the feces (69% of the total) with approximately 30% being excreted through the milk and only about 1% being excreted through the urine. This is in contrast to carnivores (meat-eating animals) where the majority of phosphorus is excreted through the urine instead of the feces. Scientists have calculated that 2 to 3 acres of cropland per cow and her replacement heifer are required for manure disposal in order to maintain a zero phosphorus balance on a farm.

Our goal when feeding cattle is to provide an adequate amount of phosphorus to optimize performance, health, and efficiency at an economic cost while minimizing the amount excreted via the feces. Feeding excessive amounts of phosphorus increases the cost of rations. Approximately 50% of the cost for mineral/vitamin premixes is associated with phosphorus. Secondly, feeding more phosphorus than needed increases the amount of phosphorus excreted in the feces and this additional phosphorus must be accounted for in environmental-nutrient management programs. Thus, adequate, but not excessive amounts, of phosphorus should be provided to cattle.

The concentration of phosphorus found in forages varies depending on the plant species, soil fertility, and stage of maturity the forage/plant is harvested. Forages need to have their mineral content determined via wet chemistry methods in order to balance rations for phosphorus content. In addition, the phosphorus content of

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grains vary considerably. Analyzing not only forages but also grains, byproducts, and protein supplements are needed when formulating rations in order to minimize the amount of phosphorus excreted. With cattle, the total amount of phosphorus found in the feedstuff can be used to calculate the amount of phosphorus supplied in the diet since the rumen microbes can use phytate phosphorus as a phosphorus source.

Phosphorus Deficiencies

Phosphorus deficiencies are rare, but can be seen in ruminants that graze forages grown on soils *very low* in phosphorus or those consuming overly mature forages or crop residues with low phosphorus content. In severely deficient cattle, growth rates, feed efficiency, voluntary feed intake, and reproductive efficiency are decreased. In extremely deficient cattle, bone mineral content is decreased and the bones can easily break. The key to preventing phosphorus deficiencies is to consistently provide adequate amounts of phosphorus. This means the complete mineral needs to contain the appropriate concentration of phosphorus and cattle need to consume adequate amounts of the mineral. With cattle consuming pasture with no additional grain, this often means providing a well-fortified, free-choice complete mineral (where salt content regulates intake) which provides the proper amount of phosphorus. Cattle do not consume the correct proportions and amounts of minerals other than salt to meet their nutritional needs. In the classical studies with growing heifers and milking dairy cows, no evidence was found to support the claim that the appetite of cattle for phosphorus coincided with their nutritional needs to correct the deficiency. Thus, phosphorus needs to be force-fed to insure cattle consume adequate amounts either through free-choice mineral supplements where salt regulates intake or through grain mixes or TMR.

Excessive Amounts of Dietary Phosphorus and Milk Production Responses

No improvements in milk production or dry matter intake have been seen in research trials where phosphorus has been supplemented above estimated requirements. In a study by Satter and Wu, these scientists suggested that diets should contain 0.38 to 0.41% phosphorus (dry matter basis). They indicated that typical diets in the US contain 0.36 to 0.38% phosphorus before supplementation so little additional supplementation is needed. In addition, milk composition has not consistently been altered in studies where phosphorus was supplemented above requirements. During early lactation, increasing the concentration of dietary phosphorus above requirements for milk production, increased total phosphorus excretion but did not improve phosphorus balance, dry matter intake, or milk production. Mobilization of bone in response to the needs for calcium provided a readily available source of phosphorus during early lactation. Bone stores of

phosphorus can be replaced later in lactation when cows are in positive phosphorus balance.

Effects of Excessive Phosphorus on Reproduction

Increasing the dietary concentration of phosphorus above requirement does not improve reproductive performance. Scientists have found that reproductive performance was not different on the lower but adequate concentration of phosphorus when compared to cows fed a higher concentration (above requirements) of dietary phosphorus. Thus, increasing the concentration of dietary phosphorus above requirement (above 0.38-0.40%) does not improve reproductive performance.

Summary of the reproductive performance of lactating dairy cows fed lower and higher concentration of phosphorus (Summary of 7 published reports and 785 cows)		
	Phosphorus Concentration (% diet DM)	
	Lower (0.32 to 0.40%)	Higher (0.39 to 0.55%)
Days to first estrus	46	48
Days to first AI	73	76
Days open	96	100
Services per conception	1.8	1.9
Pregnancy rate	0.87	0.86

Wu et al. 2000 J. Dairy Sci. 83:1028

Environmental Effects of Excessive Phosphorus

Cattle need to be provided with adequate amounts of phosphorus to meet their nutritional needs. However, as the amount of phosphorus supplied in the diet increases above requirement, the excess is excreted into the manure. This additional phosphorus will be present in the manure being applied to cropland. By minimizing the amount of phosphorus excreted, rations are cheaper while protecting the environment.

Take Home Points

1. The majority of phosphorus within the body is found within the bones and teeth. Phosphorus plays a vital role in almost all metabolic reactions and energy transfers within the body.
2. Phosphorus must be provided in adequate amounts for optimal growth rates, feed efficiency, milk production, and reproductive efficiency. However, over supplementing phosphorus does not improve milk production or reproductive performance. Early lactation cows do not need additional phosphorus because they can mobilization phosphorus from bone to provide the additional phosphorus needed.
3. Supplementing diets with more phosphorus than necessary increases the amount of phosphorus excreted in the feces. To dispose of this additional phosphorus, additional acres of cropland for manure disposal may become necessary if application rates of phosphorus to cropland are regulated.