

Phosphorus Requirements, Sources, and Excretion in Dairy Cows

Since the 1960s, several researchers have examined P metabolism in the lactating dairy cow. In the previous NRC (1989) publication on dairy cattle nutrient requirements, P requirements were increased by 10% to 22% to adjust for dietary P availability in common feeds. This publication gives the P requirement as 0.49% for the first 3 weeks of lactation and then 0.38% to 0.42% for cows in early to midlactation.

Recent research from the U.S. Dairy Forage Research Center in Madison, Wisconsin (Satter and Wu 1999, Wu et al. 1998) confirms that high-producing dairy cows require approximately 0.40% P in the dietary dry matter for optimal milk production and reproductive performance. Although it is a common practice to feed 0.50% to 0.60% P in some parts of the United States, these controlled studies indicate no benefit of these high levels. Feeding higher than recommended levels of dietary P has not improved either milk production or reproductive efficiency in controlled research studies. In line with this research, the most recent NRC (2001) recommends lower dietary P levels.

Phosphorus can be supplemented by adding monocalcium or dicalcium phosphate, monosodium phosphate, ammonium phosphate (*high availability*); steamed bone meal, defluorinated phosphate, sodium tripolyphosphate (*medium availability*); or low-fluorine rock phosphate, soft rock phosphate (*low availability*). Most commercial premixes contain P and must be properly incorporated into the diet.

Phosphorus that is bound to phytate, so-called phytate-P, is not readily available to nonruminant animals such as swine. However, rumen microbes produce phytase, an enzyme that effectively releases P from phytate (Morse 1989). *Phytate-P is readily available to ruminants such as dairy cattle.* Over 99% of P bound to phytate is released from wheat middlings, hominy, soybean meal, corn distillers grains, and cottonseed meal during rumen fermentation of the feedstuff (Morse 1989). *Therefore, do not over-supplement P above recommendations in a mistaken attempt to compensate for phytates in feeds.*

Phosphorus is the most expensive nutrient in typical mineral-vitamin formulations for dairy cattle. For example, feeding a ration containing 0.45% P versus a diet containing 0.55% P would save about \$0.05/cow daily. For 100 cows over a year's time, it would save about \$1,825.

Dry cows require only 0.25% P in the ration dry matter. A 1,300-pound milk cow, however, requires about 17 grams of P daily for maintenance plus 0.90 grams per every one pound of daily milk production. For example, a 1,300-pound cow producing 85 lbs of milk requires about 94 grams of P daily.

Signs of P deficiency include inactive ovaries and lack of estrus behavior (NRC 1989). Cows may eat wood or dirt or drink urine. Over-supplementation of P generally will not impair performance; the maximum tolerable level is 1.0% of the ration dry matter. However, dry cow health may be impaired when excessive P is fed during the dry period. Over-supplementation of P also leads to increased environmental risks due to excessive P content of the manure. Keep in mind that commonly fed commodity feeds and byproducts can vary substantially from source to source in content of nutrients including P and other minerals. When formulating diets containing byproduct feeds, it

Recent research from the U.S. Dairy Forage Research Center in Madison, Wisconsin, confirms that high-producing dairy cows require approximately 0.40% P in the dietary dry matter for optimal milk production and reproductive performance.

Clearly, a dairy producer has considerable control over mineral excretion in the manure by manipulating the amount of mineral in the feed.

Remember, the goal is to keep excretion of N, P, and K as low as possible while maintaining optimum dairy cow performance.

is important to test regularly for nutrient content and to adjust the ration accordingly. In some cases, using least-cost ingredients increases the diet's P level over NRC (2001) recommendations. For example, a traditional diet containing alfalfa, corn silage, soybean meal, and corn would contain about 0.40% to 0.45% P. In contrast, a diet with 30% to 40% corn gluten feed, although costing less, would contain between 0.55% to 0.60% P. Dairy producers need to weigh the relative feed cost savings versus the potential cost of excess nutrient excretion.

Excretion estimates of P in Table 12-1 show that a dietary P content of 0.40%, 0.45%, or 0.60% results in estimated annual excretion of P of 40 to 46 to 69 pounds per cow. Clearly, a dairy producer has considerable control over mineral excretion in the manure by manipulating the amount of mineral in the feed.

Feeding adequate P is important for cow performance and health, but 0.40% to .45% of the dietary dry matter is near the optimal dietary content for lactating dairy cows. For a cow producing 100 to 120 lbs of milk daily, a diet containing 0.45% P meets the NRC (1989) recommendation. However, the same dietary P level provides about 140% of the daily P requirements for a cow producing only 40 to 50 lbs of milk.

From this observation, we can determine that the milking herd must be grouped by production level and that multiple rations must be formulated over the complete lactation cycle to minimize P excretion into the environment. This is hardly an earth-shattering statement. Remember, the goal is to keep excretion of N, P, and K as low as possible while maintaining optimum dairy cow performance.