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Enzyme Overview

Phytase - Unlocking Available Phosphorous

Unlike carbohydrase enzymes which function to liberate additional energy from vegetable feedstuffs, the primary function of phytase is to liberate available phosphorus (Av P) through the hydrolysis of phytate-bound phosphorus (PP).

Phosphorus (P) is an essential nutrient which is required by all animals for a myriad of biological functions, such as proper bone maintenance and development, energy metabolism, amino acid formation and blood pH balance (ref 1). Poultry receive their dietary P from either plant-based P in grains and oilseeds, animal byproduct meals, or inorganic mineral sources such as dicalcium or deflourinated phosphate. For example, corn contains 0.26% total P but only 0.07% AvP. Meat and bone meal contains 5% total P and 4% AvP, and dicalcium phosphate contains 18% total P and 17% AvP. Inorganic and animal byproduct P sources are typically highly digestible (between 80-100%). However, plant-based P is largely indigestible (varies by ingredient, but generally less than 50% digestible) to poultry due to the fact that it primarily exists in the form of PP (only 30% Av P) addition to the detrimental effect of PP on digestibility, another consequence is increased accumulation of P in soils due to poultry litter application, in some cases resulting in legislation to reduce the level of litter application or require the use of exogenous phytase (ref 2).

The indigestibility of PP is a consequence of its chemical structure. PP exists as an inositol ring (see diagram 1) of six individual phosphate molecules joined by ester bonds. In addition to binding Av P, PP has a strong negative charge, which makes it very capable of forming further complexes with dietary minerals, which carry a strong positive charge, thereby reducing the availability of both P and dietary minerals (ref 2).

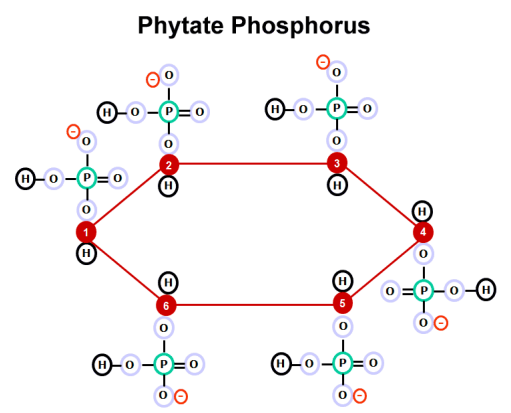

Diagram 1

In order to access the P contained in the molecule, poultry need phytase enzyme activity. Phytases are capable of breaking the ester bonds linking the phosphates in PP, thereby allowing the bird to utilize more of the P contained therein. Poultry do produce some endogenous phytase activity. However, much of this is age dependant, as older birds are more efficient phytase producers than chicks (ref 3).

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Phytase - Unlocking Available Phosphorous (cont'd)

In spite of the presence of some endogenous phytase production, research seems to suggest that the use of exogenous, microbial phytase allows poultry to be much more efficient at utilizing PP (ref 4). In general, the addition of microbial phytase allows the producer to improve the dietary Av P status from 0.07% to 0.15%, depending on sources and inclusion levels (ref 5).

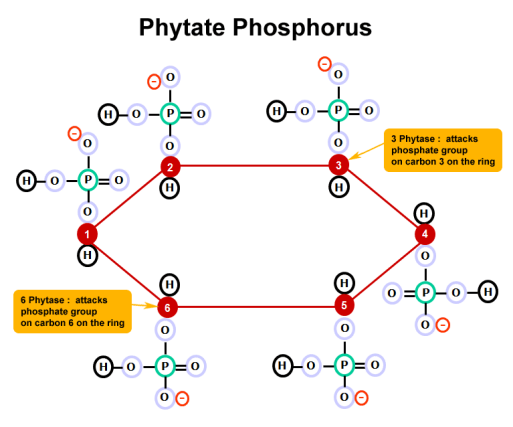

Diagram 2

Some controversy exists between suppliers as to the effectiveness of different phytase sources at hydrolyzing PP. Exogenous phytases can either be termed 3-phytases or 6-phytases (ref 6). This designation simply refers to the position on the inositol ring where the phytase exerts its function (see diagram 2) as 3-phytases attach to the phosphate in the 3-position, whereas 6-phytases attach at the 6-position (ref 2). Many feel that the 6-phytases are superior, as research has demonstrated that 3-phytases do not always completely dephosphorylate the PP molecule, whereas 6-phytases do (ref 7).

Additionally, exogenous phytases can be derived from fungi or bacteria. Some research has demonstrated that bacterial phytases are more effective at liberating Av P from PP (ref 8). This improvement in effectiveness is likely related to the effects of pH on the hydrolysis of the phytate molecule. Most PP hydrolysis likely occurs in the crop, gizzard and proventriculus where the pH is more conducive to optimal phytase activity (ref 9).

Fungal-derived phytases have been shown to exhibit peak phytase activity at two distinct pH levels - 2.5 and 5.5 (ref 10). However, research has demonstrated that E. coli-derived phytases have peak phytase activity anywhere between a pH of 2.5 to 3.5. The primary site for phytase activity in the digestive tract of poultry is probably the crop (ref 11). However, research has demonstrated that E. coli-derived phytases also continue to exert their function in the small intestine, whereas those derived from fungi display minimal activity there (ref 12). This is possibly due to increased resistance of E. coli-derived phytases to degradation by the animal's own proteolytic enzymes, which has been demonstrated in vitro (ref 13). That being said, recent research has demonstrated the efficacy of fungal-derived phytases at degrading PP, particularly when used in conjunction with intermittent lighting programs, which increase the retention time of feed in the crop (ref 14).

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Phytase - Unlocking Available Phosphorous (cont'd)

REFERENCES

Reference 1: Selle and Ravindran, 2007; Singh et al., 2008.

Reference 2: Angel et al., 2002.

Reference 3: Maddaiah et al., 1964; Maenz and Classen, 1998.

Reference 4: Simmons et al., 1990; Quian et al., 1996; Yi et al., 1996; Zyla et al., 1996; Mitchell and Edwards, 1996; Quian et al., 1997; Carlos and Edwards, 1998; Rao et al., 1999; Waldroup et al., 2000; Yan et al., 2001.

Reference 5: Augspurger et al., 2003.

Reference 6: Selle and Ravindran, 2007.

Reference 7: Wodzinski and Ullah, 1996.

Reference 8: Igbasan et al., 2000; Augspurger et al., 2003; Cowieson et al., 2008; Plumstead et al., 2010.

Reference 9: Selle and Ravindran, 2006.

Reference 10: Rodriguez et al., 1999.

Reference 11: Liebert et al., 1993; Takemasa et al., 1996; Kerr et al., 2005.

Reference 12: Onyango et al., 2005.

Reference 13: Igbasan et al., 2000.

Reference 14: Saylor et al., 2009; Liem et al., 2010.

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