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Phytase Enzyme and its Remarkable Effects on Chicken Health

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Abstract

Phytase enzyme catalyzes the hydrolysis of Phytate to mono, di, tri, tetra and penta Phosphate of Myoinositol and Inorganic Phosphate. Cereals, legumes and oilseeds are the main ingredients of animal feed. Phytic acid or phytate is the chief storage form of phosphorus in the feed obtained from these plant sources. Phytate bound important mineral, metal ions and amino acids with it, and in this way it is anti-nutritional element. Simple stomach animals for example pigs, birds (including poultry), and fish cannot metabolize phytic acid phosphorus, because of the reason that they have very limited levels of phytic acid degrading enzyme activity in their digestive tracts. Thus, in order to meet the nutritional requirements in poultry and swine feed inorganic form of phosphate is added frequently in feed. Microbial action in soil and water can easily convert phytic acid into free phosphate and in this way phosphorus pollution will be resulted which includes eutrophication which can be defined as pollution due to excess of phosphate in water that promote excessive algal growth which in turn decrease concentration of oxygen in water. Phytase simply changes phytic acid into free phosphate by its hydrolysis. In this way it provides phosphorus for the body consumption of monogastric animals. In addition to it, phytase also provide amino acids, minerals and metal ions to simple stomach animals by releasing them from phytic acid. Phosphorus pollution causes eutrophication which may be defined as decrease in oxygen concentration and increase in growth of Algae which is very dangerous for aquatic life. Phytase enzyme reduces eutrophication (phosphorus pollution) by converting phytate or phytic acid into less phosphorylated and less toxic form.

Keywords: Phytase, phosphorous toxicity, phytic acid and poultry

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INTRODUCTION

Phosphoric acid, specifically in the form of cereal by-products, oil cakes, and cereals, makes up over 85% of the total phosphorus in feedstocks. Phosphorus (phytate) is not well utilised by chickens under typical dietary conditions, and as a result, it is eliminated through them. The bird's need for phosphorus, therefore, has to be met through adding diet with inorganic phosphorus sources such as defluorinated phosphate or by adding exogenous enzyme which can hydrolyze phytic acid. In addition to creating difficulties in locating the proper materials for routine use, traditional practice of supplementing chicken rations with inorganic phosphorus raises the expense of feeding. Exogenous enzymes have been used in an aggressive attempt in recent years to increase the nutritional content of feeds. Based on numerous investigations, it can be concluded that adding the right amount of phytase, carbohydrase, and other enzyme activities might enhance the nutritional and financial value of cereals and other substances that are frequently used in chicken feeds worldwide. Phosphorus plays a major role in growth, maintenance and metabolism of carbohydrates and fat. It is essential part of phospholipids and nucleic acid. Phosphorus is a major part of adenine triphosphate and creatinine phosphate, both of these are essential in energy metabolism. Phosphorus is a primary mineral in poultry diets and its better utilization is essential for economic poultry production. In addition to phosphorus phytase provide other essential minerals, metal ions and amino acid to poultry birds as it hydrolyze phytic acid which, otherwise binds these important nutrients and does not release them for body consumption.

Environmental Issue of Pollution

The addition of exogenous phytase in poultry diets is necessary to decrease P losses into environment. Excessive P in environment is a big threat to water because P is the major cause of euterification of water reservoir on land wether these are river, lakes or ponds [1]. Surface runoff due to high concentration of P which is excreted by monogastric animals into environment, this may lead to unnecessary growth of highly toxic algae, these algae can kills fish [2].

Phytate and Its Nutritional Value

Phytate, phytic and phytic acid, these are interchangeable terms but mostly used term is phytate.

Phytate is a substance included in plant-based feeds. During the early phases of seed germination, the P element serves as a reservoir for P, and the integral phytate shields the seed from oxidative stress throughout its life [3]. The presence of phytic acid in cereal grains has been known for more than a hundred years ago, yet its role in animal nutrition is not fully known. Though, it act as anti-nutritional factor by binding with phosphorus and other essential nutrient in monogastric especially in poultry reducing bioavailability of many nutrient [4]. It is reaveled by many researcher that phytate is not digestible by monogastric animals and act as anti-nutritional factor presence of phytate in cereal and their byproducts act as P source for germination of seed. Chicken have limited phytase activity so digestion of phytate is not sufficient and availability of P is very low and variable. Phytate has the ability to bind with many cationic nutrient through chelation because phytate itself have negative charge, which is basic and most important reason for behaving as anti-nutritional substance. The chelation ability of phytate require extra research in this area because it may bind with many other nutrients e.g. calcium, amino acids and trace minerals. Phytase is present in nature widely, it is the only enzyme which have the ability to hydrolyze phytate and capable of releasing inorganic phosphorus from phytate).

Phosphorus is an vital mineral for a large no of biochemical pathways, physiological developments and skeletal integrity, but due to the limited availability of phytate-P, diets are added with P sources such as DCP (dicalcium phosphate) or, by the addition of meat and bone meal to fulfill the dietary requirements . It might be argued that P needs have not been precisely or consistently defined, and that exogenous enzymes that can hydrolyze phytate now fully satisfy this requirement. Because the world's sources of rock phosphate are finite, relying solely on inorganic P additions presents a dilemma [5].

Phytase and its Sources

It is well studied in many researches that exogenous phytase has valuable effect in poultry diet by liberation of inorganic P from phytate and by increasing bioavailability of other nutrients e.g. protein, mineral especially calcium and energy [6]. During the last two decades addition of enzymes in poultry feeds is a common practice for the improvement and better utilization of nutrients. These enzymes capable of digestion of nonstarch polysaccharides (NSP) in broiler diets NPS present in wheat and barley [7]. In 1962 it was observed that addition of phytase in broiler feed improve phytate P utilization and bone mineralization [8]. Phytate cannot be broken down by the monogastric pump, although it can be hydrolyzed by phytoase. According to Vihnudhas [9], the majority of phytate is found in cereal grains and byproducts. In addition to reducing phytate to produce myoinositol penta, tetra, tri, di, and mono-phosphates in a sequential manner, phytolase also mitigates the negative effects of phytate on protein and other nutrients in the diet of animals that are monogastric [10]. Phytase activity is inherent in several feed components, primarily wheat and its byproducts [11]. However, the importance of plant phytase in typical diets is questionable because it is less active than microbial phytases at digestive pH and may be deactivated by acidic pH levels in the gastrointestinal. Besides, the practical importance of plant phytase is weakened because it will be reduced or even abolished by steam-pelleting of pig and poultry feeds. Because plant phytases are heat sensitive, most of them are destroyed in minutes at temperatures above 70°C when they are purified [12].

Mucosal phytase was first seen in rats by Pathwardhan [13] in 1937. It has since been found in the small intestines of pigs, poultry, and humans [14]. Though mucosal phytase is rarely given much thought, dietary calcium may have an effect on its activity because it can combine with phytate to generate an insoluble complex. This Ca–phytate complexes in small intestine has some adverse effects on intestinal phytase and its activity on phytate. Therefore, the extent of phytate degradation produced by mucosal phytase will be partial by the Ca levels in pig and poultry diets [15].

Phytase activity is known to be produced by the microfloral population in the gut, especially in the hindgut, but the hindgut's phytate degradation is not very significant. Pigs and poultry produce undigested phytate-P, yet hindgut fermentation, particularly in pigs, may significantly lower the amount. Although coprophagic animals may benefit from hindgut fermentation of phytate-P, this complicates total-tract evaluations of phytate breakdown because P released postileum seems to be of minimal use to the animal [16].Currently, the mostly of phytases are obtained from *Aspergillus niger* (fungi) or, more recently, *Escherichia coli*, However, it should be noted that genetically modified material is not found in preparations of phytase feed enzymes. It is also possible that the quantity of phytase activity and its purity, or the absence of enzymatic side activities, have grown over time as a result of improved production techniques. This change may have the effect of causing the microbial phytases that were assessed in the early research [17-19] to differ from the feed enzymes that are currently on the market.

Effects of Exogenous Phytase on Chicken Health

It has been recommended that phytase in poultry feeds improves health of gastrointestinal (GIT) tract by reducing secretion from GIT which later on increases the utilization of energy [20, 21]. It was observed in recent research by providing maize based feed that phytase play a role by increasing co-enzyme Q10, Q10 act as antioxidant in body by counteracting free radicals [22]. It is also observed that phytase has the ability to improve glucose level in pigs [23, 24].

Phytase and Availability of Phosphorus

It is approved in many researches that microbial phytase enzymes has increased the phosphorus utilization. By the utilization of phytase environmental pollution has been decreased. Phytase is capable of liberating inorganic P by hydrolyzing phytate and reduces P excretion [19].

'Energy Effect' of Phytase

It's possible that phytate inhibits the digestion and utilisation of energy, but phytase has the opposite, beneficial impact. This is a significant potential. Microbial phytase consistently increases metabolizable energy of broiler diets, but the effect of phytase on digestible energy of pig feeds is not as obvious [25].

Phytase and Calcium Availability

Many studies have been conducted in poultry to determine the availability of P by adding exogenous phytase. Though, few studies also present on Ca availability and it is postulated that phytase liberate phytate-bound Ca. Possibly one third of dietary Ca is present as Ca–phytate complexes in intestinal digesta [6].

Phytate and Amino Acids Availability

There is an evidence that phytase also increases protein and energy utilization. When phytate is present in the diet, the availability of dietary amino acids and energy is decreased [4,26]. Proteins that are more easily digested can provide more energy; phytate and phytase functions have been addressed in relation to this. It has been demonstrated that phytate interacts with fats through the creation of "lipophytins," which are complexes of lipids, peptides, calcium, magnesium, and phytate [27].

Phytate, Phytase and Sodium

Phytate has very different effects on sodium loss in broiler when broiler offered atypical diet phytate has ability to increased Na flow four times, which is decreased by phytase almost up to 44% [28]. These effects were also observed in broiler growing on conventional diet [29]. Phytate, derived from rice bran, increased Na excretion at the ileal level by 60% and phytase decreased these excretion by 66% [28].

CONCLUSION

To conclude it is scientifically proven that phytase enzyme plays key role in poultry feed and therefore must be provided in poultry feed for better health and growth of poultry birds.

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