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REVIEW ARTICLE

PHYTASE AND ITS APPLICATIONS

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ABSTRACT

Phytase, myo-inositol 1,2,3,4,5,6-hexakisphosphate phosphohydrolases (EC 3.1.3.8) belongs to a sub-class of the family of histidine acid phosphatase that initiate stepwise removal of phosphate from phytate. Facing the problem of phosphorus deficiency in plants and animal feed together with its pollution in areas of intensive livestock production, phytase seems destined to become increasingly important. Hence, for both environmental and economic concerns, phytases and phytase-producing organisms are attracting significant industrial interest. This review provides the information about the applications of the phytase.

INTRODUCTION

Phytase belongs to a large family of phosphohydrolase enzymes and is a unique acid phosphatase as it can catalyse hydrolysis of phytate to inositol and orthophosphoric acid. The International Union of Pure and Applied Chemistry and the International Union of Biochemistry (IUPAC–IUB) distinguish two classes of phytate degrading enzymes, 3-phytase (EC 3.1.3.8) and 6-phytase (EC 3.1.3.28), initiating the dephosphorylation at the 3 and 6 positions of phytate, respectively (Guilan *et al*., 2009). Up to now, phytase has been mainly, if not solely, used as a feed supplement in diets largely for swine and poultry, and to some extent for fish. The benefits of phytase are two-fold: saving the expensive and non renewable inorganic P resource by reducing the need for its inclusion in animal diets and protecting the environment from pollution of excessive manure Phosphorus runoff.

Application of Phytase

Application of transgenic plants cloned with phytase gene

"Biofarming" of the phytase is a cost-effective approach to its production (Al-Wahsh *et al.*, 2005). Native *Aspergillus ficuum* phytase has been expressed in tobacco, alfalfa and potato leaves (Ullah *et al.*, 2003). Heat stable *A. fumigates* phytase expressed in tobacco leaves is an important asset because the enzyme will then be able to withstand the elevated temperatures employed during feed pelleting processes (Wang *et al.*, 2007). Rhizosphere soil organism (*B. muciloginosus*), able to produce extracellular phytase and degrade PA in soil, has been shown to promote growth and increase P content in plant, thereby potentially limiting eutrophication (Li *et al.*, 2007).

Phytase as feed additive

Exogenous phytase in animal feed has multiple benefits, mainly in increasing mineral, phosphorous and energy uptake and thereby decreasing the necessity to fortify the fodder with these substances. The increased availability of PA, decreases P excretion and hence reducing the Pi load in water supplies in regions with intensive rearing of animals (Raboy *et al.*, 2007). Comparison of four commercially available phytases as fortifiers of pig's feed revealed that none of them satisfied all of the criteria of an ideal phytase for feed production, such as resistance to denaturation under extreme temperatures and pH (Boyce and Walsh, 2006). Experiments have also shown that exogenous Zinc (Zn) supply can be reduced to approximately 1/3 in maize and soybean based diet in the presence of microbial phytase. In broiler chickens, supplementing with exogenous phytase has reduced excretion of endogenous amino acids, calcium, sodium, phytate phosphorus and sialic acid significantly. Exchanging a meat based protein-rich diet with a lower cost plant protein diet would be desired by the industry of aquaculture (Selle and Ravindran, 2007). Fish having short gastrointestinal tracts, are quite sensitive to the micronutrient utilization, dephytinisation of the plant material is consequently an important prerequisite to this application (Shobirin *et al.*, 2010). However, fish have a basic environment (pH 8) in the gastrointestinal tract which does not

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correspond to the conditions for optimal phytase activity; therefore the acidic microbial phytases may not be the first choice of enzyme.

Phytase as food additive

Degradation of PA during breadmaking has been known to affect mineral bioavailability for many years (Mollgaard, 1946). Several bread making procedures designed to diminish the phytate content therefore include addition of commercial phospho-esterases from wheat (phytase or phosphatase) to whole wheat flour and activation of naturally occurring phytase by soaking and malting the grain (Kadan *et al*., 2007). Phytase shows potential as a bread making improver, with two main advantages: (i) the nutritional improvement produced by decreasing phytate content, and (ii) all the benefits produced by an α-amylase addition (increase in bread volume and improvement in crumb texture) can be obtained by adding phytase, by releasing calcium and thereby promoting the activation of α-amylase (Haros *et al.*, 2001). Most recent research showed that soy flour is the type of soy-bean product containing the highest amount of phytate (Al-Wahsh *et al.*, 2005). There are many reports on the supplementation of poultry and swine diets with yeast phytase to improve nutritional status of feed (Stahl *et al.*, 2000) and enhancement of plant growth by phytase production (Hayes *et al*., 2000). Supplementation of yeast to animal feed and to soil as bio-inoculants can be an alternative approach to tackle P unavailability effectively because many yeast strains are already being taken as Single Cell Protein (SCP). However, since any single phytase may never be able to meet the diverse needs for all commercial and environmental applications therefore, there is ongoing interest in screening microorganisms, including yeasts, for novel and efficient phytases.

Pulp and paper industry

It has been speculated that the removal of plant phytic acid might be important in the pulp and paper industry. A thermostable phytase could have potential as a novel biological agent to degrade phytic acid during pulp and paper processing. The enzymatic degradation of phytic acid would not produce carcinogenic and highly toxic by-products. Therefore, exploitation of phytases in pulp and paper process could be environmentally friendly and would assist in the development of cleaner technologies (Liu *et al.,* 1998).

Concluding Remarks

Phytases have lots of applications. However, since any single phytase never be able to meet the diverse needs for all commercial and environmental applications therefore, there is ongoing interest in screening microorganisms, including yeasts, for novel and efficient phytases.

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