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ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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# Economic and Environmental Impact of Using Exogenous Enzymes on Poultry Feeding

Fernando Guilherme Perazzo Costa, C.C. Goulart, D.F. Figueiredo, C.F.S. Oliveira and J.H.V. Silva
Department of Animal Science, Federal University of Paraiba, Areia, Brazil

## Introduction

Exogenous enzymes supplementation on diets improves production efficiency of poultry by increasing the digestion of low quality products and reducing nutrient loss through excreta, allowing the reduction of diets nutritional levels with likely economic advantages. Enzymes are added to animal ration with the goal of increasing its digestibility, removing antinutritional factors, improving nutrient availability, as well as for environmental issues. A large number of carbohydrases, proteases, phytases and lipases are used for this purpose (McCleary, 2001). Usually, commercial enzymes used as additives do not contain a single enzyme, instead, they are enzymatic preparations containing a variety of enzymes, which is eligible and once rations are composed by ingredients of different constitution (Campestrini *et al*., 2005).

According to Buchanan *et al*. (2007) exogenous enzymes hydrolyze non-starch polysaccharides (NSPs) which might be potentially used by the animal, increasing the usage of feed energy. Moreover, the releasing of cell content occurs, becoming available to enzymatic digestion, therefore increasing the digestibility of all nutrients. Another important consequence of this utilization is the reduction of such non-digestives residues negative impacts on digesta viscosity (Slominski *et al*., 2006).

Phytase, in its turn, hydrolyzes phytate that is found in every ingredient from vegetal source. Phytate is a polianionic molecule with potential to chelate nutrients positively charged ($Na^{+}$, $Mg^{++}$, $K^{+}$, $Ca^{++}$ and $Zn^{++}$, among others), characterizing its antinutriotional property, which compromises utilization of protein, energy, calcium and trace-minerals (Selle and Ravindran, 2007). Consecutively, phosphorus and other elements become available for metabolism and animal (Roland, 2006).

Hence, this review aims to present the economic and environmental impacts of enzymes utilization in poultry diets.

**Economic impacts:** Economic benefits from exogenous enzymes utilization on poultry nutrition is related to feeding costs reduction, allowing the flexibleness on diets formulation and / or a better performance, as well as better litter quality and birds' health, which, thus, will influence on total production costs.

**Flexibilization of low cost diets formulation:** Availability and variety of grains in Brazil are great, which permits the total or partial inclusion and/or substitution of certain ingredients by others with reduced prices, mainly during the time between harvests. However, such ingredients also named alternatives present some restrictions as for their use in poultry diets formulation, due to the presence of antinutritional factors that impair performance and consequently, result in low uniformity and profitability at the end of production. Enzymes utilization allows that those ingredients are used as efficiently as corn and soybean do (Campestrini *et al*., 2005). Xylanases act providing higher values of metabolizable energy, resulting in greater weight gain and improvement in feed: Gain ratio as much for wheat (Hew *et al*., 1998; Wu and Ravindran, 2004; Tufarelli *et al*., 2007) as for triticale (Pourreza *et al*., 2007).

According to Wyatt and Bedford (1998), there are different economic approaches when considering enzymes incorporation on diets formulation. A simpler and probably, more practical application, called "over the top", aim to improve performance more economically, and consist in supplement a standard diet with enzymes, without alter its nutritional levels. Another alternative is to manipulate diet formulation by reducing nutrients and adding exogenous enzymes in order to restore the nutritional value of the standard diet, seeking the same performance that a diet with normal nutritional levels would provide. If supplementation is efficient, productive parameters would be the same (Zanella *et al*., 1999). The possibility of using enzymes in reformulated diets must be evaluated, in which the enzyme nutritional matrix is to be considered during diets formulation, allowing a grater reduction on feeding costs, since enzymes contribute with 50 to 75 kcal of ME, 0.1% of Ca and 0.1% of available P by kilogram of ration (Wyatt and Bedford, 1998).

Angelovieova *et al*. (2005) report that an important indicator of the effective feed utilization is the ratio between feed intake and each kilogram of body weight gain (feed: Gain ratio). Consequently, an economic evaluation of feedstuffs used in diets can be simply attained through cost feeding by gain kilogram calculation. These authors verified that exogenous enzymes utilization (xylanases and proteases) improved, in average, 8.41% and 2.51% the efficiency of feed utilization of a wheat-based diet in the first and second assays, respectively. Bedford and Morgan (1996)

recommend the utilization of enzymatic complexes in diets using wheat as main ingredient due to the feeding costs reduction, reached through the greater metabolizable energy (+6%) and amino acids (+10%) availability.

Torres *et al.* (2003) evaluating the enzymes influence on broiler chickens performance, verified that lower energy and protein levels, supplemented with enzymes, provided the broilers a similar performance of those fed diets with normal nutrient levels without affect performance and reducing costs, consequently.

Likewise, phytase utilization represents a potential economy, since by turning the phytic phosphorus available, makes unnecessary inorganic phosphorus supplementation, resulting in reduced diet formulation cost. Studies performed by Plumstead *et al.* (2008) evaluating phosphorus reduction in the diet associated with phytase supplementation, achieved interesting results on chick production by housed breeder fed those diets, allowing the reduction of inorganic phosphorus levels of the diets, decreasing expenses without affect negatively broiler breeder performance.

**Higher nutrient digestibility and better poultry performance:** Nutrient digestibility can be improved with exogenous enzymes supplementation. According to Rutherfurd *et al.* (2002) phytase addition improves minerals retention and amino acids, fat and carbohydrates digestibility. Kocher *et al.* (2003) verified an increase of AMEn of corn and soybean based diets for broilers with a combined supplementation of pectinase, protease and amylase only when basal diets presented low protein and energy. Yu and Chung (2004) verified that the addition of appropriate levels of $\alpha$-amylase, $\beta$-glucanase and xylanase in diets with 3% of ME reduction for broiler chickens resulted in similar performance to the obtained with the control diet.

Studies developed by Strada *et al.* (2005), using diets formulated with overestimated values in 9% for ME and 7% for amino acids, supplemented with multi enzymatic complex Vegpro, showed an improvement on ME and amino acids (Met, Met+Cys and Lys) efficiency of utilization. The authors concluded that energetic and amino acidic density reduction of diets based on corn and soybean meal, containing multi enzymatic complex, do not compromise broiler chickens performance and might be a resource on production costs reduction.

Recently, Roland (2006), supplementing phytase on diets for broiler chickens deficient in phosphorus, verified an improvement on amino acids and carbohydrates digestibility. Plumstead *et al.* (2008) verified that phytic phosphorus reduction on diets results in greater phosphorus retention by birds, therefore, phytase utilization can be used as a tool to optimize this mineral utilization. Brito *et al.* (2006), evaluating the interaction between exogenous enzymes supplementation (protease, cellulase and amylase) and extruded soybean on broiler chicks diets, verified that this addition improved weight gain in 3.8% and feed: Gain ratio in 4.2% of broiler chicks from 1 to 21 days. These data demonstrate the real efficiency given to birds fed exogenous enzymes in their diets, in order to rebound directly on production costs reduction, due to make possible to reduce energetic and proteic levels of these enzymes inclusion.

**Improvement on litter quality:** NSPs increase diets' viscosity due to its capacity of bonding to great amounts of water and forming a viscous gel (Santos Jr. *et al.*, 2004), decreasing the rate of diffusion of substrates and digestive enzymes (Choct, 2001). In order to reduce digestive content viscosity it is necessary that soluble NSPs to be decomposed in small unities through enzymatic action and losing their water retention capacity. With viscosity reduced, enzymatic action on intestinal content is more efficient and therefore, there is improvement on nutrient digestion capacity, increase on intestinal transit rate and reduction of water amount in feces, providing a better litter quality (Opalinski, 2006).

Nagaraj *et al.* (2007), studying the effects of enzymes supplementation on broiler chicken diets on incidence reduction of pododermatitis in broilers, verified lower viscosity of supplemented birds' digesta. These authors relate positively viscosity reduction with the reduction on litter moisture e lower incidence of wounds in older birds, concluding that enzymatic supplementation of diets might be a tool aiding to control pododermatitis.

**Improvement on birds' health:** Several studies show that the use of xylanolitic enzymes inhibits fermentation at the ileum and stimulates fermentation at cecae (Bedford, 2001; Persia *et al.*, 2002). Reduction of ileal fermentation is beneficial to the host, because most of the fermented material at this region constitutes of undigested starch and protein, which, thus, become available for hydrolyses ad absorption by the host (Bedford, 1996). Moreover, oligossacharides resulting from NSPs degradation by exogenous enzymes are likely to have a prebiotic effect at cecae, acting as substrate for proliferation of beneficial bacteria to the host to the detriment of pathogenic bacteria, therefore improving bird health (Persia *et al.*, 2002).

Hinton *et al.* (1993) reported that the greater production of lactic acid at the ileum and propionate at the cecae with xylanase utilization on diets wheat based favors a better intestinal health in broilers, due to the bacteria which produce lactic acid promote a competitive exclusion and propionate is toxic for *Salmonella* and other pathogenic bacteria.

**Environmental impacts of exogenous enzymes utilization on poultry feeding:** Environmental pollution is defined as contamination by poisons, substances produced by men, animal production and other organisms (Williams, 1995).

Researches with enzymes have demonstrated the importance of these substances to reduce the negative effect of antinutritional factors and improve feed efficiency. Phytase presents effective capacity of improve phytic phosphorus usage, mainly from feedstuffs presenting high phytate levels and therefore, reduces the pollutant potential of excreta, making poultry husbandry a more ecologically activity (Schoulten *et al.*, 2003).

During the process of diet's nutrient conversion into animal products, considerable losses occur, even if animals are at ideal production conditions, with quality feeding and appropriate handling. It is possible to make use of several nutritional manipulations in order to reduce nutrient excretion and the most efficient measures include rations counterbalancing in such way that attends more precisely to animals' requirements, pure amino acid addition, reducing simultaneously the diet crude protein level and finally, enzyme addition to the diet.

Once evidenced carbohydrases efficacy, these might promote the increase of sub products from vegetal sources, reducing diets production costs and also cooperating with environmental protection due to the reduction of nutrient excretion (Schoulten *et al.*, 2003).

Environmental pollution, through fecal excretion of nitrogen and phosphorus, can occur in higher or lower level, depending on the utilization capacity of these nutrients by animals, which is improved with exogenous enzymes addition (Campestrini *et al.*, 2005)

Birds are omnivorous animals and therefore, are not able to digest non-starch carbohydrates, as those present in soluble and insoluble fiber. Thus, many vegetable ingredients usually used in poultry diets present inferior digestibility values, when administrated to birds in comparison to animals with superior fermentative capacity, as swine. The improvement of birds' digestive capacity through the use of supplementary enzymes, is presented as a serious alternative to, not only improve animal performance, but also as a mean to reduce excreta amount, which decreases the contaminant potential of the production environment and therefore, becomes an alternative to be considered to attenuate the effects of growth promoters withdrawal (Vieira, 2003).

Birds excrete more than half of phosphorus and nitrogen they consume. Enzyme use in poultry and other livestock animals diets improves digestibility and availability of certain nutrients for animal, mainly phosphorus, nitrogen, calcium copper and zinc, diminishing its presence on feces and urine and hence, its deposition to the environment (Campestrini *et al.*, 2005). The hidden benefits from the use of glucanases in birds fed viscous cereals include the reduction of excreta amount eliminated to the environment, as well as the diminution of problems associated to moist feces, as dirt eggs, elevated gas production (ammonia) and the presence of flies and rodents in the facilities (Choct, 2001).

According to Rutherfurd *et al.* (2002), microbial phytase addition to poultry diets might retain minerals and improve amino acids digestibility and this way, reduce costs and environmental impacts, since nitrogen and phosphorus concentration in excreta are reduced.

Phytases present generalized applications, once its substrate is unchangeably present in diets for poultry and swine and its inclusion results in greater phosphorus bio-availability and in excretion reduction of this mineral to the environment. The prohibition of using protein meals from animal sources has accelerated the phytase acceptance and utilization as additive in animal diets in some countries. This enzyme capacity of release phytic phosphorus and reduce the excretion to the environment is well documented; phytase is a economic and alternative phosphorus source and since phosphorus natural resources are not renewable, its use would be beneficial, inclusively for such contingent preservation (Selle and Ravindran, 2007).

Studies performed by Leytem *et al.* (2008) demonstrate that phytic phosphorus reduction on diets may result in lower excretion of this mineral on birds' excreta. Silva *et al.* (2008) verified that the manipulation of protein and P levels in diets supplemented with amino acids and phytase can reduce, mainly, P, N and Cu excretion, minimizing environmental pollution caused by these elements.

**Final Considerations:** Exogenous enzymes show up as tools on poultry diets formulation flexibilization, allowing the utilization of non-conventional ingredients without impairment to birds' performance, with consequent reduction on production costs.

Additionally, enzymatic supplementation can reduce environmental problems, improve livestock surrounding, reducing wounds and improving, therefore, birds' welfare.

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