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Research Paper

Effects on Processing Use of either Liquid or Powder Enzymes in Animal Feed -Review

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ABSTRACT
The objective of this research study was to review of liquid and power enzymes uses in the feed manufacturing technology. This study also reveals that role and function of enzymes and types of enzymes in pig, poultry, cattle, pet and fish feed industries. It was found that there were four types of enzymes currently dominate the animal feed market enzymes to break down fiber, protein, starch and phytic acid. To break down anti-nutritional factors that are present in many feed ingredients, these substances, many of which are not susceptible to digestion by the animal's endogenous enzymes, can interfere with normal digestion, causing poor performance and digestive upsets. There was importance role in processing of feed in pelleting, expansion and extrusion process while making of feed. Enhances the feed intake and efficiency, growth rate and productivity Increase the energy value of cereal feed stuff, Better digestibility of feed ingredients by better feed conversion
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I. INTRODUCTION

Enzymes are biological catalysts, or chemicals that speed up the rate of reaction between substances without themselves being consumed in the reaction. Enzymes are the protein molecules which are involved in the metabolic reactions in the body. These enzymes act as catalysts to various biochemical reactions that take place both in the cell and in extracellular fluids such as stomach acid. They leave the reaction as they entered it with no net chemical changes to the enzyme itself, although some enzymes will chemically react with substrates to form enzyme-substrate intermediates part way through a reaction. They accelerate the reaction by decreasing the activation energy of the reaction and by weakly binding and orientating substrates into reaction favorable conditions. Enzymes can be called biocatalysts. Enzymes as additives to animal feedstuffs have had a great impact on the livestock industry. Not only have they improved the utilization of diets containing cereals such as barley, wheat, rye, and oats, especially for poultry, but also they have improved the quality of the environment by reducing the output of excreta and pollutants, such as phosphate and nitrogen, including ammonia. Enzyme supplementation of cereal-based diets has been instrumental in producing more uniform performance values in poultry and tends to be more efficacious with wheat and barley with low apparent metabolize energy (AME) values than with cereals with higher AME values. Cereals with low AME values often have a high content of growth-inhibiting, viscous, water-soluble, non-starch polysaccharides (WSNSPs); as a result, the response to enzyme treatment is greater than that obtained with cereals with a lower concentration of WSNSPs. The net effect of adding enzymes to cereal-based diets is, therefore, increased AME values and more uniform performance values. Enzymes have also been shown to decrease the size of the gastrointestinal (GI) tract, which, in addition to increasing the partitioning of nutrients into edible tissue, alters microbial fermentation, which may affect the availability of nutrients. This may in turn affect the health status of the animal. Most enzymes are proteins but not all proteins are enzymes. These Types of Enzymes:

- Isomerases - Involved in isomerization reactions
- Ligases - Used to join bonds (ATP is required)
- Hydrolases - Involved in the hydrolysis of bonds in the presence of water
- Transferases - These types of enzymes are helpful to transfer one substrate to another.
- Lyases - Involved in non-hydrolytic cleavage of bonds
- Oxidoreductases - Involved in oxidation and reduction reactions

Enzymes also allow the use of a wide range of ingredients without compromising bird performance and hence provide great flexibility in least-cost feed formulation. Alleviation of gastrointestinal morbidity and other diseases in animals, such as swine dysentery and acidosis in ruminants and horses, is another possible benefit of feed enzymes. Aim of this study to fine out the role of enzymes in feed manufacturing technology

Why use enzymes in animal feeds?
The principal rationale for the use of enzyme technology is to improve the nutritive value of feed stuffs. All animals use enzymes in the digestion of food, those produced either by the animal itself or by the microbes present in the digestive tract. However, the digestive process is nowhere near 100% efficient; for example, swine are unable to digest15–25% of the food they eat. Therefore, the supplementation of animal feeds with enzymes to increase the efficiency of digestion can be seen as an extension of the animal's own digestive process. In many animal production systems feed is the biggest single cost and profitability can depend on the relative cost and nutritive value of the feeds available. Often, the limiting factor when formulating rations is the animal's ability to digest different constituent parts of the feed raw materials, particularly fiber. Despite recent advances, the potential nutritional value of feedstuffs is not achieved at the animal level. This inefficiency in the utilization of nutrients can result in a cost to the farmer, the food company and the environment. Put simply, there are three main reasons for using enzymes in animal feed:

1. To increase the availability of starches, proteins and minerals that are either enclosed within fiber-rich cell walls and, therefore, not as accessible to the animal's own digestive enzymes, or bound up in a chemical form that the animal is unable to digest (e.g. phosphorus as phytic acid).

2. To break down specific chemical bonds in raw materials that are not usually broken down by the animal's own enzymes, thus releasing more nutrients.

3. To supplement the enzymes produced by young animals where, because of the immaturity of their own digestive system, endogenous enzyme production may be inadequate.

In addition to improving diet utilization, enzyme addition can reduce the variability in nutritive value between feedstuffs, improving the accuracy of feed formulations. Trials have shown that ensuring feed consistency in this way can increase the uniformity of groups of animals, thus aiding management and improving profitability. The general health status of animals can also be indirectly influenced, resulting in fewer of the non-specific digestive upsets that are frequently provoked by fiber components in the feed of increasing importance and relevance to the feed industry are the environmental benefits of harnessing enzyme technology. Since the animal better utilizes the feed, less is excreted. This results in manure volume being reduced by up to 20% and nitrogen excretion by up to 15% in pigs and 20% in poultry. As significant is the opportunity for enzymes to reduce phosphorus pollution.

Role of Enzymes in Poultry and Pigs:
The mechanism by which enzymes improve the nutritive value of cereals was discussed by Francesh et al. (1994). Their assumption was that enzymes that are added to the diet complete the digestive function of the gastrointestinal tract in mono-gastric animals, thereby improving the digestion and absorption of nutrients. However, animal performance is also closely related to the regulation of metabolism and functioning of the endocrine system. Few points are as follows that are benefits of enzymes in poultry and pigs.

- Enzymes act as supplement to the normal digestive enzymes especially during stress condition.
- Reduce anti-nutritional products like tannins, saponin and goitrogen.
- Release minerals for assimilation- e.g.: Ca, Mg, Zn, P etc.
- Stabilization of microbial flora by making these nutrients readily available to them
- Checks chelating of minerals such as Zn, Mn, Fe, Ca, K with phytic acid, less chelating means more minerals availability

Role of Enzymes in Cattle:
Due to the relatively high cost of feed enzymes, the inconsistency of responses, and the potential of improving animal performance with the use of other emerging technologies, the use of enzymes in ruminant diets was, until recently, abandoned high costs of livestock production combined with the availability of new enzyme preparations has prompted a renewed interest in the potential of feed enzymes for ruminants. Commercial enzymes used in the livestock feed industry are products of microbial fermentation. Feed enzymes are produced by a batch fermentation process, beginning with a seed culture and growth media (Cowan, 1994).Once the fermentation is complete, the enzyme protein is separated from the fermentation residues and source organism.

Although the source organisms are, in many cases, similar among enzyme products, the types and activity of enzymes produced can vary widely depending on the strain selected and the growth substrate and culture conditions used (Lee et al., 1998)

Role of Enzymes in fish

In fish larvae, basal capacity and rates of the intestine to hydrolyze and transport specific nutrients is qualitatively and quantitatively set in genetic 'memory' to correspond to a natural diet. With this premise in mind, we should be able to produce "artificial zooplankton" which would satisfy the needs of all larval fish. At first feeding, the digestive tract in most fish species contains the enzymes related to metabolism (digestion, absorption and assimilation) of molecules such as proteins, lipids and glycogen. The enzymes' activity has been observed to be relatively low compared with adult fish levels. Each enzyme develops independently during ontogenesis, with variation related to fish species and temperature. Kolkovski (2001)suggested that the live food (i.e. zooplankton) organisms consumed by the larvae assist the digestion process by 'donating' their digestive enzymes, either by autolysis or as zymogens that activate the larval endogenous digestive enzymes. Live food organisms also contain gut neuro-peptides and nutritional 'growth' factors which enhance digestion. These substances are frequently omitted in formulated diets. Moreover, particulate diets for larvae contain proteins and other ingredients that are difficult to digest, (especially since formulated diets are 60–90% dry matter while zooplankton is only 10%). Based on this hypothesis, the inclusion of different digestive enzymes, especially proteases, in the diets for fish larvae resulted in significantly improved nutrient utilization and performance of the larvae; however, these were still not at the level of live food-fed larvae.

Function of Enzymes:

1) Balance the micro-ecological system of the digestive system in the animal or fish

-It helps to improve the animal digestive environment and the types of bacteria structure. It helps to improve the reproduction of the beneficial bacteria and restrict the reproduction of harmful bacteria. It helps to supply the culture which is essential to the yeast, yeast bacteria and lactobacillus. This will help to increase the effective concentration of yeast bacteria, lactobacillus and cellulose bacteria.

2) Increase the Feed Conversion Ratio

-It helps to improve the effective utilization ratio of all kinds of nutrition in daily feed, especially the effective utilization ratio of energy, so that the animal can increase the feed intake and the gain obvious body weight.

3) Increase the immunity of animal

-It helps to activate the macrophage, enhance the immunity system of animal.

Role of Enzymes in Pet food

There are many benefits of enzymes in pet foods which are as follows:

- Increases T-Cell (cancer fighting cell) production and activity within a short period after digestion.
- Raises white cell blood count.
- Contains over 77 Ionic minerals.
- Promotes weight loss in overweight animals.
- Strengthens the immune system.
- Improves nutritional absorption and energy level.
- Reduces hunger craving often seen in kibble fed pets.
- Decreases risks of degenerative disease, cholesterol, plaque buildup and toxins in the body.
- Enables the body to obtain nutrients from food.

Function of liquid enzyme

Blend of organic acids with stabilizers and buffered base that maintains the acidic pH of the gut to prevent growth of any harmful bacteria in poultry. Blend of liver stimulants, choline chloride, yeast extracts, vitamins and antioxidants to prevent any liver damage or disorder in poultry.

Powder Enzymes

S.N	Type	Form	Function
1	Cellulase	Powder	To assist in breaking down the complex molecules of cellulose into more digestible components of single and multiple sugars
2	Xylanese	Powder	Helps to digest high molecular weight Arabino-xylans in animal feed and breaks down insoluble cell wall material of cereals and liberates extra nutrients making it Freely available to the animal. Degradation of soluble NSP improves nutrient diffusion in the gastro-intestinal tract
3	Amylase	Powder	Digests the starch into small segments of sugars and into soluble sugars
4	Protease	Powder	Splits protein into their components, amino acid building blocks
5	Pectinase	Powder	Splits protein into their components, Amino acid building blocks.
6	β-Glucanase	Powder	Breaks down β-Glucans present in wheat and barley diets to increase energy utilization and reduce sticky droppings in birds.
7	Lipase	Powder	Acts on triglycerides, converts FFA and Glycerol
8	Hemi-Cellulase	Powder	Act on arabinoxylans and mannans, releasing pentose sugars and metabolize hexose sugars from SFC, wheat, DORB, causing reduction in digesta viscosity

Liquid Enzyme Stability

Liquid enzymes are inherently less storage stable than their granular counterparts. In liquid form, water activity is sufficiently high for the component enzymes to remain active, whereas in the granular form the low water activity renders the component enzymes relatively inactive prior to ingestion by the animal. Commercially available enzymes are typically less than 100% pure and often contain side enzyme activities in addition to the desired main activity or activities. These side activities can include trace levels of proteases which, even at low activity, can cause some degradation of the main activities (e.g. Xylanese). An aqueous environment also introduces a significant risk of microbial contamination and proliferation, which can cause rapid decline in enzyme activity in liquid products. The problem of storage stability is increased further when different liquid enzymes are mixed to produce ‘multi-enzyme’ liquid products and when liquid enzyme products are stored at ambient temperatures in different parts of the world.

Effects on processing

Because of evident positive results, enzymes are quite extensively used in poultry and pig diets. However, since the processes of compounded feed manufacturing involve exposure to high temperatures and pressure (pelleting, extrusion, expansion, etc.) these processes have to be considered as very aggressive to the enzyme, from the standpoint of enzyme stability. Enzymes are regularly added to the feed mix in either one of two accepted methods. Some companies prefer to add the enzyme in a solid form, as a component of the premix formulation. In this case it will pass through the pelleting process, assuming no significant losses will be produced during pelleting. The increase in the severity of the processing treatment underlines the importance of enzyme stability. Several approaches have been taken to overcome the difficulties; including avoidance of the treatment altogether by adding the enzymes as a liquid after the pellets have cooled. Despite the possibility of post-pelleting supplementation, feed enzymes are often added to the mash before treatment. The effects of heat may be reduced by protection of the enzymes with hydrophobic coatings or selection of heat-resistant enzymes. (Pickford, 1992) reported that concern for feed-borne pathogens and factors of pellet quality have caused feed manufacturers to increase the processing temperature, time and pressure, and feed has been submitted to double pelleting or expansion. Steen (1999) suggests that if a feed is to be processed at a temperature above 90°C, even enzymes that have been stabilized should be added after processing.

Pelleting Process:

Pelleting can be defined as a mechanical process in which the effects of friction, pressure and extrusion coincide along with a given temperature rise. Pelleting can be considered as the most important development achieved in the history feed production since its very beginning. In spite of the obvious benefits obtained from pelleting, one should not forget that the better the pelleting process, if we base it on the improvement in digestibility and reduction in its microbial contamination, the greater is going to be the loss of micronutrients and additives such as enzymes. While referring to enzyme supplementation, we know now that the steam applied for pelleting is a key factor in the maintenance of their activity. Several studies have shown that the effect of pelleting On enzymes has to be considered in three well defined steps of the process. The first one would be the preconditioning chamber, where steam applied will generate an increment in heat and humidity; the second occurs at the level of the pellet die, where heat is produced while the feed is forced through the die perforations and the third and last is cooling of the pellets, where temperature must fall rapidly until room temperature is achieved.

Expansion and extrusion process in feed manufacturing

Extrusion as well as expansion is a hydrothermal process that can be included in the high temperature-short time processes where pressure is modified. Most expanders work under 25-40 bars of pressure and temperatures between 9O-13O0C, with treatment times between 5 and 20 seconds (Angulo and Puchal, 1995), expansion having become a regular process for meal before pelleting. In wet extrusion, feeds are subjected to high levels of moisture (20-35%), with pressure and heat treatment generated by the extruding screw and steam that can be maintain during several minutes.

Fiber-degrading enzymes

One of the main limitations to digestion is the fact that mono-gastric (pigs and poultry)do not produce the enzymes to digest fiber. In diets containing ingredients suchas wheat, barley, rye or triticale, a large proportion of this fiber is soluble and insoluble arabinoxylan and β-glucans(White *et al*., 1983; Bedfordand Classen, 1992). The soluble fibre can increase the viscosity of the contents of the small intestine, impeding the digestion of nutrients and thereby reducing the growth of the animal. It has also been linked with the incidence of digestive disorders such as non-specific colitis in swine, and sticky litter and hock burns in poultry. The fibre content of wheat and barley can vary considerably according to variety, growing location, climatic conditions, etc. This in turn means that there can be considerable variability in the nutritional value of these ingredients and hence diets containing them. In breaking down the fiber, enzymes (e.g. xylanase targeting arabino xylans, β-glucanase targeting β-glucans) can reduce this variability In nutritional value, giving rise to improvements in the performance of the feed and the consistency of the response. An added benefit is the reduced incidence of certain digestive disorders. Eeckhout *et al*. (1995**)** measured the activity of a β-glucanase included in a commercial piglet feed conditioned at temperatures between 50 and 95°C and pelleted at temperatures between 72 and 91°C.

Protein-degrading enzymes

Various raw materials contribute to the protein content in the diet and ultimately the amino acids that fuel lean meat deposition. There is considerable variability in the quality and availability of protein from the different raw materials typically found in monogastric diets. Within the primary vegetable protein sources such as soybean meal, certain anti-nutritional factors (ANFs), such as lectins and trypsin inhibitors, can lead to damage to the absorptive surface of the gut, impairing nutrient digestion. In addition, the underdeveloped digestive system of young animals may not be ableto make optimal use of the large storage proteins found in the soybean meal (glycinin and conglycinin).The addition of a protease can help to neutralize the negative effects of the proteinaceous ANFs in addition to breaking down the large storage protein molecules into smaller, absorbable fractions.

Starch-degrading enzymes

To many nutritionists maize is viewed as the ‘gold standard’ of raw materials. Most nutritionists do not consider maize digestion as being poor: in fact most would argued that it is better than 95% digested. However, recent evidence presented by Noy and Sklan (1994) suggests that, at the illeal level, starch digestibility rarely exceeds 85% in broilers between 4 and 21 days of age. The addition of an amylase to animal feed can help to expose the starch more rapidly to digestion in the small intestine, and in doing so lead to improved growth rates from enhanced nutrient uptake. At weaning, piglets often suffer a growth check because of changes in their nutrition, environment and immune status. The addition of an amylase, usually in conjunction with other enzymes, to augment the animal’s endogenous enzyme reduction has been shown to improve nutrient digestibility and absorption and, hence, growth rate for a range of diets (Close, 1995).

Phytic acid-degrading enzymes

Phosphorus is required for bone mineralization, immunity, fertility and growth and is an essential mineral for all animals. Swine and poultry digest only about 30–40%of the phosphorus found in feedstuffs of vegetable origin, with the remainder being tied up in a form inaccessible to the animal phytic acid. In many instances additional phosphorus must be added to the diet to meet the animal's requirement. More than half of the phosphorus consumed from such feedstuffs is excreted in the faeces, which can result in major environmental pollution. By adding a phytase to the diet, the phytic acid is broken down, liberating more of the phosphorus for use by the animal. The two main benefits of phytase supplementation are, firstly, the reduction in feed costs from the reduced additional supplementation of phosphorus to the diet and, secondly, environmental from reduced excretion of waste products and the threat of pollution. There are several studies which indicate that microbial phytase supplementation increase the body weight gain and feed intake in broiler chickens. Simons et al. (1990) reported that microbial phytase supplementation of low phosphorus maize-soybean diet increased the availability of phosphorus to over 60% and decreased the amount of phosphorus in the droppings by 50%.Kies et al, (2001) reported that the diets with addition phytase by fattening chickens have influence to the increase growth and body weight. Gibson (1995**)** studied three phytase preparations to a wheat-based feed and pelleted the feed at temperatures of 65–95°C. Two of the preparations suffered inactivation even at 65°C and only a commercially available stabilized preparation retained substantial activity with pelleting at 85°C or above.

CONCLUSIONS

Enzymes have changed the way nutritionists select ingredients for a nutritionally balanced, least-cost diet. Using feed enzymes can also alleviate the problem of environmental pollution and control certain diseases. Enzymes will play an indispensable role in 21st-century animal production. The full benefit of enzyme use may be realized by reducing the nutrient density of the diet by tying the enhancement in nutrient digestibility to the wheat fraction of the diet. Future research need more precise identification of the most desirable catalytic properties of enzymes that are required for different classes of livestock and poultry and the effects that enzymes have on the physiological and endocrine responses of animals fed cereal-based diets. Research in the future should clarify some of these problems. Enzymes as feed additives not only have had a very great impact on the livestock industry but will continue to provide an ever increasing range of benefits in the future. There are many challenges in this rapidly expanding field.

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