

# **Role of Enzymes in Poultry Nutrition**

**Neospark**

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## Introduction

At the most basic level, feedstuffs consist of protein, starch, fat and fiber. In monogastric animals the fiber component has been considered to be wasted and in some instances, compounds called Non-starch polysaccharides (NSP) can exert anti-nutritive activity on the animal. The NSP of barley, wheat and rye has been the most intensively investigated. Beta glucan in concentrations ranging from 30-60 g/kg dry matter has been shown to depress production in broilers and cause sticky droppings (pasted vents).

Wheat and rye contain relatively high levels of arabinoxylans or pentosans (50-80 g/kg dry matter for wheat; 100 g/kg dry matter for rye) which can also have a negative effect on broiler performance. Ingestion of NSP by monogastrics results in increased viscosity of the digesta. This increased viscosity reduces the passage rate of the feed leading to overall reductions in consumption and decreased performance, sticky droppings and dirty eggs. The addition of enzymes to the diet to address NSP viscosity can improve feed efficiency, improve manure quality and increase the use of lower cost feed ingredients.



## Characteristics of Enzymes

### Effectiveness of an enzyme include:

1. Specific degradation site in the molecule
2. PH value
3. Temperature
4. Water content
5. Presence of aerators / Inhibitors
6. Substrate concentrations

Animal nutrition requires the enzymes, which are active at 40°C and also withstand at 70-80°C (Pelleting temperature).

### Pre-requisite of Enzyme used in Animal Nutrition:

- Must act under acidic pH condition of stomach
- Resist low pH
- Resist pepsin's proteolytic action
- It should act other parts of digestive tract

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Plant enzymes	Microbial enzymes
Narrow spectrum hydrolyzing enzymes.	Synthetic broad-spectrum hydrolytic enzymes.
Less stable in extreme reaction conditions.	More stable enzymes on extreme reaction conditions.
Standardization not done.	Better standardized.
Lower yield.	Higher yield.
Not economical.	Economical.

## Advantage of Microbial Enzymes Production

- Microbes are capable of producing a variety of enzymes.
- Due to high production capacity, there is unlimited supply of enzymes.
- Production capacity can be expanded by strain improvement.
- They can be manipulated easily in the laboratory.
- Large number of enzymes can be obtained economically from microorganism.  
Only well-designed, & intensive search among microbial strains can usually find an appropriate organism to produce any enzyme.
- It is possible to introduce genetic changes in them rather easily, due to simplicity of their genome.
- Their growth requirements are simple & can be precisely defined, which is of immense importance in industrial production to maintain consistency of product quality.
- Specific enzyme conversion is required. The only disadvantage is the presence of contaminating enzymes, which can cause undesirable reaction. These contaminated enzymes can be removed by enzyme purification techniques.

## For production of enzymes

1. Select suitable strain
2. Composition of nutritive media

## Enzyme producing micro-organisms

### Fungi:

- Largest group among enzyme producing micro organism

Aspergillus spp. (*A. niger*)  
Penicillium spp.  
Humicola spp. (*H. insolens*)  
Trichoderma spp.

- These fungi produce enzymes for degradation of various substances. But they all have one thing in common i.e. the production of enzymes for the breakdown of plant cell wall components in the form of high polymer carbohydrates.



### Bacteria:

- Bacillus spp. ( $\alpha$ -Amylase, proteases)
- *B. licheniformis* and *B. subtilis*

## Microbes used in commercial enzyme production:

ENZYME	SOURCE	ACTION
$\alpha$ -amylase	Bacillus subtilis Bacillus licheniformis Aspergillus oryzae	Endo-hydrolysis of $\alpha$ -1, 4-glucosidic linkages
$\beta$ -glucanase	Bacillus subtilis Aspergillus niger Penicillium emersonii	Degrades $\beta$ -glucan by cleaving $\beta$ -1,3(4) glucosidic linkages
Pectinase	Aspergillus oryzae Aspergillus niger Rhizopus oryzae	Degrades pectin $\alpha$ -1,4-linked anhydrogalacturonic acid
Pullulanase	Klebsiella aerogenes	Splits the $\alpha$ -1,6-glycosidic linkages

## Substances other than NSP (Non-starch Polysaccharides)

- Indigestible oligosaccharides (present mainly in vegetable protein carriers)
  - $\alpha$ - Galactosides
  - Raffinose
  - Stachyose
  - Verbascose
  - Phytic acid (Ester of hexa-phosphoric acid of inositol)
  - Tannins
  - Phytates
  - Lactins
  - Vicins
  - Trypsin inhibitors

## Classification of Polysaccharides

<b>Homopolysaccharides</b>	Glucans	Starch Dextrins Cellulose
	Fructans	Levan Inulin
<b>Heteropolysaccharides</b>	Hemicellulose pectin Mucilage Gum	

## Effects of NSP compounds and phytate in animals

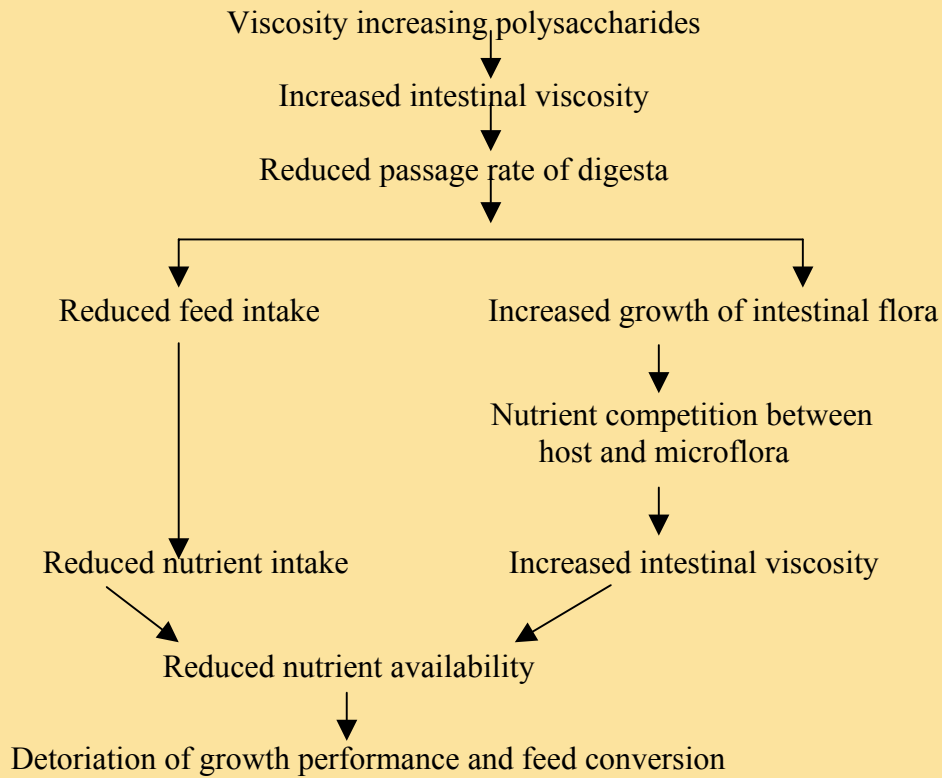
### 1. Influence on energy density (Dilution effect)

- Poorly digestible
- Dilute the metabolizable energy
- Dilute the nutrient content of feed

### 2. Entrapping of nutrients (Cage effect)

- Entrapping other nutrients mainly starch, fat and protein
- This is applied to the insoluble parts of the NSP which are present in the various cell wall structures.

### 3. Increasing the viscosity of digesta



### 4. Reduction of nutrient absorption

In this, multiple factors take part

- Viscosity
- Altered composition of intestinal flora
- Increased absorption of bile
- Influence on the intestinal mucosa

Reduced nutrient absorption



Higher than normal excretion of digestive enzymes



Endogenous loss of protein

**According to the purpose of application, feed enzymes can be fundamentally divided in to:**

a. Enzymes which are to quantitatively supplement endogenous digestive enzymes of mono gastric animals

Eg. Proteases, lipases, Amylases

b. Enzymes which are not produced by mono gastric animals

Eg.  $\beta$ -glucanases  
Pentosanases  
Phytases.

## Role of enzymes in poultry nutrition

### General:

- ✓ Poultry do not produce enzyme for the hydrolyses of these nonstarch polysaccharide (NSP) present in the cell wall of the grains
- ✓ Addition of enzymes specific for a given feed formulation will enhance the bioavailability of above feed components.
- ✓ The exogenous enzyme in feed additive, can complement to endogenous enzymes in the digestive system during adverse climatic condition and at an early age, to give an increase role of digestion.
- ✓ The production of endogenous enzymes may be a limiting factor due to various reasons depending on the age, health, type of feed, environment etc.



### Enzyme Stability

#### In animals:

- For optimum activity an enzyme should be capable of surviving low pH of 2 in stomach and high pH of 6.5 in the intestine.
- The temperature inside the animal digestive system is significantly lower than that which causes enzyme in activation.

#### In feed:

- Enzymes are stable at 80 - 85<sup>0</sup>C for 1-2 min as required for pelleting and pH of 5.5 to 6.5 in feed.

### Mode of Action

Addition of enzymes to feed functions in various ways in birds body thus improving its nutrients utilization and overall performance.

#### 1. By reducing the gut viscosity:

- Cereals contain high proportions of their energy in the form of non-starch polysaccharides
- Cereals contain soluble indigestible polysaccharides like arabinoxylan (wheat), mixed linked  $\beta$ -glucans (in barley and rye), lignin, limit dextrin, antinutritional factors like phytic acid and cellulose fibre
- These NSP are able to bind large amount of water - increasing viscosity in the gut - affects rate of passage of digesta - rate of mixing of bile, pancreatic and intestinal secretions with digesta -rate of absorption of digesta - increases the amount of sticky droppings.

**Addition of suitable multienzyme preparation improves animal performance in following ways**

**a. Increasing the effectiveness of host (endogenous) enzymes:**

- ❖ Breaking down the gel form characteristic of soluble fibres allows the birds digestive enzyme to function more efficiently. This improves starch, protein, fat, amino acids and energy digestibility.

**b. Alteration in feed passage rate:**

- ❖ The enzymes reduce the water holding capacity of the gut contents thus increasing the dry matter content stimulating feed intake.

**c. Effect on Excreta characteristics:**

- ❖ Addition of enzymes also reduces the dry matter outside the body thus has marked impact on excreta volume and composition. Due to protein digestibility lowering of excreta output is observed.

**d. Effect on litter problems:**

- ❖ Reduced viscosity improves nutrient digestion, lower water intake and help to reduce litter problems.

**2. Release of Nutrients:**

- Enzymatic depolymerization renders the NSP free releasing nutrients in the gut and it available to the animal.
- Starch masked by cell structure is released leading to increase in metabolisable energy.
- Proteins are also released by action of proteases. This release leads to maximum absorption of minerals and results in improvement in nutrient utilization.

**3. Availability of phosphorus:**

- Cereals and oilseeds contain 1-2% of phytate, and 60-90% of total phosphorus present in the seeds in this phytate phosphorus.
- Phytase hydrolyses phytic acid to myoinositol and phosphoric acid in step wise manner forming myoinositol phosphatic intermediates (IP<sub>5</sub>, IP<sub>4</sub>, IP<sub>3</sub>, IP<sub>2</sub>, IP<sub>1</sub>).

**Benefits of enzymes**

**A. To Poultry**

**a. In Digestibility**

1. Enhances the feed intake and efficiency, growth rate and productivity.

2. Increases the energy value of cereal feed stuffs. More nutrients are made available by hydrolysing fibrous material.
3. Better digestibility of feed ingredients by better feed conversion.
4. Enzymes act as supplement to the normal digestive enzymes especially during stress condition.
5. Reduces antinutritional products like tannins, saponin and goitrogen.
6. Promotes weight gain and overall improved performance.
7. Release minerals for assimilation - eg: Ca, Mg, Zn, P etc.
8. Stabilization of microbial flora by making these nutrients readily available to them.
9. Checks chelating of minerals such as Zn, Mn, Fe, Ca, K with phytic acid, less chelation means more mineral availability.
10. Prevents precipitation of pentacalcium phosphate and there by improves absorption of calcium and phosphorus.

#### **b. In Animal Health**

1. Improvement in animal hygiene and health.
2. Corrects digestive disorders especially when birds are crowded.
3. Fattening performance is increased.
4. Prevents damages to chicken anaemia agent.
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6. Checks cellular damages caused by toxins.
7. Promotes growth to bones.
8. Prevents diarrhoea due to poor fibre digestion.
9. Minimizes excreta, water droppings and of ammonia.
10. Reduces viscosity and ammonia level in intestine.

#### **c. In Poultry Product**

1. Increases egg production and hatchability in layers.
2. Egg quality is also maintained. More cleanly eggs and with thick shell is maintained.
3. Improves flock uniformity leading to more consistent sized birds.
4. Improved slaughter results, high carcass weights and better grading.
5. Genetic Potential of birds can be explored enabling them to consume more quality of feed to achieve maximum growth and production.

### **B. To feed**

1. Greater flexibility in feed formulation.
2. Readily available material can be advantageously utilized.
3. Use of newly harvested grains.
4. Use of cheaper raw materials as choice of raw material is increased. Barley can be easily used in place of wheat.
5. Feed additives hold promise to lower the overall production cost. Better profits as inexpensive feed stuffs can be taken.



6. Cereal replacement due to use of enzymes. High M.E. cereals can be fully replaced by low M.E. cereals without compromising growth performance.
7. Elimination of anti-nutritional factors from feed and feed ingredients eg: galactoside and pectins etc.

### **C. To environment**

1. Reduction in manure volume.
2. Reduced nitrogen and Phosphorus exertion.
3. Less environmental waste and therefore less pollution.
4. Reduced environmental stress resulting from reduced litter volume.

### **Use of Enzymes in Feed**

- ❖ To enhance the feed intake and efficiency growth rate & productivity, by overcoming many nutritional problems and correcting digestive disorders especially when birds are crowded
- ❖ To increase the energy value of cereal feedstuffs. More nutrients are made available by hydrolysing fibrous material
- ❖ To minimise excreta, waterly dropping and ammonia
- ❖ To reduce anti-nutritional products like tannins, saponins and goitrogens
- ❖ To provide choice of raw materials. For eg. Barley, which was not earlier used, is now successfully used with enzymes.
- ❖ To promote faster growth by increasing feed efficiency and promoting weight gain
- ❖ To increase egg production and hatchability in layers
- ❖ To reduce early mortality due to the problems associated with harmful moulds and aflatoxin in poultry feeds.

### **Advantages**

- ✓ Enzyme-added feed provide additional option where certain feedstuffs are in short supply
- ✓ Readily available materials can be advantageously utilised
- ✓ Price advantage over more traditional and inexpensive feedstuffs can be taken
- ✓ As growth promoters, feed enzyme additives hold promise to lower the overall production costs while improving the performance of birds
- ✓ The genetic potential of birds can be explored, enabling them to consume more quality of feed to achieve maximum growth and production.

## The Hidden Benefits Of Enzymes

### Reduction in manure out put:

- ✓ Wet excreta leads to dirty eggs and they are not suitable for sale as second – grade eggs.
- ✓ Wet droppings may also cause increased gas production (i.e. ammonia) and fly and rodent population in the shed.
- ✓ Wet dropping can also affect the health of the staff working in the shed.

### Improved well being of birds:

- ✓ Coccidiosis control, change in gut microflora and elimination of certain diseases.
- ✓ An increase in digesta passage rate and reduction in excreta moisture are often noted when glycanases are added to poultry diets, which may be detrimental to the life cycle of the organism.
- ✓ It is often noted that addition of antibiotics to high soluble-NSP poultry diets markedly improves bird performance (Misir and Marquardt, 1978).
- ✓ Enzyme supplementation largely eliminated the fermentation in the small intestine and improved nutrient digestibility and the well-being of the birds.

### Increased precision and flexibility in least cost feed formulation:

- ✓ An increased precision in least cost feed formulation, hence a more uniform performance of the birds.

Enzymes also allow a wide range of ingredients to be used in a diet with a desired outcome. This gives the producer a great deal of flexibility to formulate a nutritionally balanced least-cost diet.

## Conclusions

It is now well recognised that ingredients such as maize, soybean and, particularly, grain byproducts contain relatively high levels of dietary fibre and that this fibre has negative impacts on feed digestibility and performance. This allows for the option of using the enzyme to improve growth and feed:gain or, alternatively, to use it in diets with lowered levels of energy and protein/amino acids, with higher by-product levels, to maintain performance with lower net feed costs.

For Further information please refer to our Product details of:

- [SynerZyme-FS](#)
- [SynerZyme-P-FS](#)